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ELECTRICAL PRODUCT IN 1903.

In accordance with our usual custom we present herewith an estimate of the production of electrical apparatus in 1903. As will be seen, the figures given below represent a total output of $158,650,000 as compared with $139,950,000 in 1902. There is good reason for believing that the figures of 1902 were correct, but a little doubt exists as to some of the items last year. As has been clearly shown by the census figures of the last twenty years, the usual rate of increase in electrical manufactures each year has been on an average from 15 to 20 per cent., taking good years with bad. During 1902, which was one of unparalleled activity, there is every reason to suppose that the production increased over the preceding year a full 20 per cent., but we are justified in questioning as large a gain in 1903.

ESTIMATED PRODUCTION, 1903:

Dynamos	$17,000,000
Transformers	5,000,000
Switchboards, for lighting and power	2,750,000
Motors, for all purposes	30,000,000
Storage batteries	4,500,000
Primary batteries	1,250,000
Carbons	2,000,000
Arc lamps	2,250,000
Incandescent lamps	5,500,000
Lighting fixtures	3,750,000
Telephonic apparatus	25,000,000
Telegraphic apparatus	2,000,000
Insulated wires and cables, submarine cables	30,250,000
Conduits, interior and underground	1,750,000
Rheostats, heating and cooking apparatus	2,500,000
Annunciators	250,000
Electric clocks	150,000
Lightning arresters, fuses, etc.	750,000
Measuring instruments	3,000,000
Miscellaneous apparatus	19,000,000
	$158,650,000

It will be seen that the figure of $158,000,000 represents an increase of about 10 per cent. all around during the year, and when it is remembered how sharp a check was sustained by many lines of industry in the year which has just closed it is fair to assume that such a rate may broadly represent the total, even while some of the items may be slightly more or less "off the spot." Telephonic activity, for example, in 1902, by more than one estimate, was represented by about $21,000,000. The past year it is set down at $25,000,000—a gain of 20 per cent. It may have been even higher than that, but there are elements of doubt. Electric motors in 1902 were estimated at $27,000,000 including all kinds. Last year they are put down for $30,000,000, and while this is only an increase of 10 per cent. and may be underestimated, it is undeniable that some of the largest concerns are hardly supposed to have shown a gain superior to that during the year. It will be noted that insulated wires and cables and submarine cables are set down for slightly in excess of $30,000,000, which is a gain of $2,500,000 over 1902. This seems an enormous figure, but it is substantiated by the reports of the companies themselves in 1900, and represents consumption in every other branch of the electrical field. It will of course be understood that such an item appears again in other branches, as, for example, the insulated wire used in dynamos, motors, telephone switchboards, etc., and to that extent it represents a duplication of product, but there is no way of avoiding such a feature in these calculations.

Altogether the showing of the year is quite satisfactory, and we have no reason for doubting that the production in 1904 will fall

below this figure. Allowing for errors and possible overestimates in one direction off-set by underestimates in another, it stands to reason that an industry which has already attained a production of $150,000,000 a year in manufactured goods takes its place amongst the leading mechanical industries of the country. It must be recollected that all of this apparatus serves as a constituent of great systems and plants for railway work, lightning, telephony, telegraphy, etc., so that the actual increase in investment represented during the year, including real estate, buildings, line construction, track construction, engines, turbines, etc., may well represent not far short of $750,000,000. The annual increase in capitalization in the street railway field alone is now about $450,000,000 a year, and the other electrical industries grow in proportion, although, unfortunately, capitalization is not always investment.

ARNOLD SINGLE-PHASE ELECTRIC RAILWAY SYSTEM.

Elsewhere we print an article by Mr. B. J. Arnold giving a description in full detail of his single-phase electric railway system, a preliminary account of which formed the subject of a communication by Mr. Arnold at the Great Barrington meeting in 1902 of the American Institute of Electrical Engineers. Mr. Arnold will have the sympathy of all who read the account given of the unfortunate series of delays, over a period of almost two years, which prevented a practical public demonstration of his system, and which culminated in the destruction of the apparatus by fire just prior to a public trial that had been set for the opening of the new year—a year which he in common with many others believe will inaugurate a new era in electric traction. Mr. Arnold, in the days when it was heresy to believe in the fitness of alternating current for railway work, took an open stand as its advocate, though, singularly enough, as an equally determined champion at an earlier period of the rotary substation system, and the first, we believe, to lay down such a system on a considerable scale, he had been a prime factor in establishing what for years deterred any attempts at development of alternating-current traction in this country. Believing that the solution of the problem lay in the use of single-phase and not polyphase power, he devised the system described in the article, which was experimentally tested in the early part of 1902. Had it not been for the most unfortunate series of delays, Mr. Arnold would have had the pleasure of giving the first public trial of a single-phase electric railway system operating commercially, and in electric traction would have figured as the pioneer in that art in virtue of such demonstration. The lack of such fortuitous record will not, however, obscure the value to alternating-current traction of his early and constant advocacy of the cause, and recognition of the stimulating effect which the announcement in 1902 of his system undoubtedly had in developing the single-phase situation.

The vital point of difference between the single-phase system of Mr. Arnold and the systems later developed is that all of the latter employ a commutator motor almost identical in construction with the direct-current motor, while the former uses a pure type of synchronous alternating-current motor. Since in this type the relative speed of the armature and field must always be constant, variation of operating speed is obtained by making both these members rotatable. In this manner the condition of synchronous speed with relation to the field and armature is maintained, while any operating speed between zero and synchronism is secured by rotating from an exterior source the field in a direction opposite to that of the armature; or a speed greater than synchronism may be obtained by rotating the field in the same direction as that of the armature. This exterior source consists of a compressed air outfit in connection with the car motor, which stores up energy when the motor car slows down, and gives it forth again when the car starts up; or the air storage can be increased at any time the car is running or is at rest, and the speed can be regulated at will. A salient advantage of the system is that an absolutely constant load can be maintained on the power house regardless of the stoppage of cars, and of the power required in acceleration. This follows from the fact that the car motor is always running, and when not delivering power to the car, is engaged in storing compressed air. The compressed air pumps are only idle when the car is running at synchronous speed; when reducing speed, air is being stored at a rate corresponding at each instant to the reduction of speed at that instant; and when the car is gaining speed, then is an expenditure of the stored energy corresponding to the rate of acceleration. Another advantage of the system is that a car can for a certain fixed period be deprived of any electrical supply and kept in motion by the compressed air auxiliary, as in passing through a town, in the streets of which it would not be advisable to install the high-tension supply conductor.

The disadvantage of the system is obviously the complexity introduced by the compressed air outfit, which doubtless also introduces a weight handicap. As the first practical working solution offered to the single-phase traction problem, this disadvantage was subject to offset by the great advantage of the high-tension current involved over the low voltage of the direct-current system. At present, however, the comparison is with the recent alternating-current systems, and it remains to be seen if their greater simplicity can be overcome by such advantageous features of the Arnold system as are not common to them.

THE TELEPHONE.

During the past year there have been no striking developments in the technical side of telephony, but the steady progress in the perfection of details, and especially of the minor ones, which have been so characteristic of the preceding several years, has shown no relaxation, as our weekly review of telephone invention has borne witness. The interest of inventors in automatic telephony has not abated, several new systems during the last year having been patented, and the older automatic systems have undergone steady improvement. The central energy system has become so thoroughly established in the art that an exchange not equipped for its employment may now be considered almost obsolete. A new field recently opened for telephony is in connection with railway working. The telephone, of course, has for some years been of much service as part of the dispatching system of electric railways, but its adaptation to the service of trunk line railroads has been a development of the past few years. Recently an impetus has been given to railway telephony by the perfection of a new and simple system for the simultaneous use of the same conductors for both telegraphy and telephony, and we are informed that a railway department has been established as a branch of the leading telephony organization of the country. This is not an innovation *per se,* since for ten years or more long-distance telephone lines have been utilized for telegraphic purposes. In the early stage and possibly to some extent even to-day, one who leased a private telephone line was not aware that his wires were also leased for two telegraphic circuits.

The advent of new systems and notable improvements in devices are widely heralded, but it is not generally realized what a great part the engineer, as distinguished from the inventor, has quietly played in placing telephony on its present efficient footing with respect to continuity of service, the extension of exchange service and in making possible reduction of rates. As an example, we may mention the use of lead-covered cables, which alone permits of properly distributing subscribers' lines in their present magnitude. Taking the case of great office buildings in the larger cities, each frequently con-

taining several hundred telephones, a pole line of standard construction to feed such a building, assuming it to require 300 lines, would be some 160 feet tall, the cross arms beginning 20 feet from the street. The early types of telephone cable at once reduced the space required for such a number of wires to a few hundred square inches, while with more modern cables only some 16 square inches are required in which to conduct 300 pairs of wires. The step from the early lead cables with their large conductors, fibrous insulation and parafine filling with consequent high electrostatic capacity, to the modern small conductor cable having six or more times the number of conductors in the same bulk, was no small one, and arrived at only after the most careful study and co-operation between engineers and cable manufacturers. The situation in this connection has been still further ameliorated by the beautiful invention of Dr. Pupin, consisting in so distributing inductances along the line as to neutralize the disturbing effects of capacity, whereby transmission through cables of commercial proportions may be brought to equal or even exceed that through standard aerial lines.

A somewhat curious recent development as reflected in patent office issues, is in the provision of means to prevent infection from the mouthpieces of telephones. Since according to the ethics of the medical profession a physician cannot advertise legitimately, a certain class of medical men are prone to seek notice in newspapers by sensational announcements designed to attract to them the attention of the public. One of the subjects which several years ago served for this purpose was the alleged danger of infection from telephone mouthpieces, and since then scarcely a week has gone by without the issue of a patent on a sanitary mouthpiece attachment. Telephone users would, however, doubtless welcome an aurists' newspaper campaign that might lead to thought on the part of telephone inventors toward doing away with the cause that results in the violent "sound shocks" incident to the use of the relay system, which shocks at times are so severe as to be an actual danger to the hearing. The severity apparently has some connection with the temper of the operator, but in any event any improvement which can be made by telephone companies to eliminate this annoyance will most undoubtedly be gratefully welcomed.

THE ELECTRIC RAILWAY.

The single-phase alternating-current railway question has during the past year, and particularly during the latter months of the year, completely overshadowed all other developments in the electric traction field, and the new year opens with an electric railway situation such as has not been presented since the time of the Richmond experiments. The trials at Pittsburg, Berlin and Milan of single-phase systems have all met with a success so astonishing, that in view of the previous dubious status of alternating-current traction, the entirely unexpected outcome has had a dazing affect, and it will be some time before the probable outcome will be clearly evident. One thing, however, seems sure, and that is the passing of the rotary converter from a field where, indeed, it has only been tolerated *faute de mieux*. The commutator alternating-current motor is so nearly allied to the direct-current motor that it enters the lists as a competitor to the latter for all traction purposes. Even for urban service Mr. Lamme, who speaks with authority, pronounces in its favor, the disadvantage of extra weight being considered more than compensated for by the absence of rheostatic control.

Another issue brought into the field with the single-phase development is that of the trolley vs. third rail, which bodes ill for the latter, particularly in view of the Zossen experiments, which established the sufficiency of the suspended trolley system for the heaviest service. With the voltage that will be employed with the single-phase system, an ordinary street railway trolley wire would suffice in some cases where now the third rail is required to be used in order to obtain cheaply sufficient conducting cross section. The growing feeling on the part of the public against the third rail owing to its supposed "deadly" character and unreliability in winter weather, may aid in carrying the question beyond its natural limit and make it one of overhead conductors even where in heavy service this means an equivalent of a third rail supported overhead by a substantial structure. Indeed, this appears almost a necessity in the case of the rapidly coming applications of electric traction to railroad terminal service; for the use of the third rail in the terminal yard and at crossings appears to be out of the question, and a combined overhead and third-rail system would inevitably end in the survival alone of the fittest component—and a few derailments would clearly indicate the survivor.

Next in general interest to the alternating-current development has been the announcement of the New York Central of its plans for electric traction, which in outline comprise the establishment of a zone within which all through trains will be handled by electric locomotives, orders having already been given for 30 of these of 2200 hp each, and with a maximum speed capacity of 60 miles per hour, the ultimate number to be about 300; and the handling of all suburban traffic by trains operated on the multiple-unit system. The decision in favor of the direct-current system, coming as it did at a moment when the champions of alternating current felt that they had laid low the adversary, has doubtless been a source of severe disappointment to their sanguine spirit. In due time no doubt the New York Central authorities will make public the reasons for the decision in favor of direct current, and in the meantime it can readily be surmised that this may have little or no connection with the technical superiority of either of the competing systems. In fact, being limited by statute as to the time when electrical operation shall commence, and having to consider the absolute necessity of avoiding any risk of interruption of service such as is apt to be incident to a new and untried system, the decision could scarcely have been otherwise than in favor of a system with absolutely no question as to its fitness for the service required, and involving apparatus with no experimental features inviting delay. Moreover, the question of possible interchange of cars with the New York Subway System, which had already provided for direct-current operation, was no doubt a vital factor in shaping the decision. It is thus quite probable that the selection of the direct-current system depended on considerations largely or entirely of business policy, with perhaps full recognition of the probability of a change over to alternating current before many years.

WIRELESS TELEGRAPHY IN 1903.

In wireless telegraphy the sanguine expectations of a year ago cannot be said to have been realized in 1903 to any marked degree. It is true that Marconi, last January, fulfilled his promise and definitely established the feasibility of wireless communication across the Atlantic; but the effect of this achievement was discounted by the celebrated letter "S" experiment of a year before, and the abandonment of the attempt to maintain a continuous transatlantic service had its depressing influence. Perhaps, however, the greatest blows were those received at the time of the New York fall yacht races through the sad showing there made for syntonic wireless and the malicious interference set up by rival systems, which, in the eyes of the public, not only discredited all of the systems involved but, what is much worse, discredited wireless telegraphy as a whole. The truth is, the mercenary side of the wireless telegraph movement has been

made so unduly prominent, the self-advertising which has accomplished the development has been so unblushing, and the squabbles between rival concerns so undignified, that the subject of wireless telegraphy as presented particularly in the newspaper press has well-nigh degenerated to a public nuisance.

To look at the brighter side of the situation, a most encouraging feature has been the practical demonstration during the year of the magnificent possibilities of wireless telegraphy for communication between ships and between ships and shore stations. Its usefulness also to communities physically isolated from the world has been demonstrated in several cases, notably in that of Santa Catalina, an island in the Pacific Ocean, 25 miles distant from Los Angeles, Cal., which, during the summer printed a newspaper having a wireless telegraph news service. In the matter of notable improvements in wireless telegraph systems, little appears to have been done in a practical way so far as recorded, though the patent offices of this country and of Europe have been sending out a constant stream of patents relating to wireless telegraphy. Prof. Lodge has at last come forward to make good his claims as the father of wireless telegraphy by presenting a system devised in collaboration with Muirhead, which has yet, however, to prove its practical merit. Braun claims to have found a method of directing to any point continuous trains of electric waves and also a method of largely increasing the energy emitted by the transmitting antenna. Hewitt has proposed a form of oscillator which seems to contain much promise. Tesla, Stone and Bull, as well as others, have made additions to the already long list of syntonic systems awaiting practical demonstration, and Fessenden and De Forest have put forth several new devices. In the purely scientific field much good work has been done in the investigation of the principles involved in wireless telegraphy in general and in the action of the fundamental details of apparatus in particular. The controversy concerning the nature of the etheric propagation of waves has continued to rage, with the advantage in the favor of those offering simple explanations based upon the work of Maxwell and Hertz, as opposed to brand new theories devised to fit the new phenomena developed.

An ominous happening of the year was the gathering at Berlin of an International Wireless Telegraph conference having for its purpose to lay down international regulations for the control of wireless telegraph communication. Aside from the baneful effect of governmental meddling with anything that does not directly relate to affairs of state, there is a particular menace in the case of a new development, which should not be trammeled at a period when every freedom of action is desirable. The part of wisdom would have been to allow a free development, and then deal with evils in the future as they arose. Our government has unfortunately become a party to this mischievous interference and it is much to the credit of England and Italy that representatives of those countries did not sign the protocol, with its hampering provisions. In this connection it is significant that in France the government has taken possession of all wireless telegraph stations, which will probably mean that instead of an inventor of a meritorious system or improvement having a free field for its development with willing capitalists to assist, he will be discouraged from proceeding owing to the bureaucratic barriers set in the way.

CURIOUS VACUUM TUBE PHENOMENA.

Elsewhere we print a communication from Mr. W. J. Hammer giving an account of a curious phenomenon he has noted in connection with a damaged Röntgen-ray tube. As will be seen, the tube, after having for a time been connected in an induction coil circuit, gave forth when disconnected a musical note for a considerable period with apparently no exciting cause exterior to the tube. Since the tube when removed had stored in it a considerable quantity of heat at the anode plate, the first thought is that the cause of the sound can be ascribed to some heat vibratory action, the Trevelyan "rocker" effect coming to mind in this connection. Mr. Hammer, however, appears inclined to refer the action to a condition of resonance established with respect to some etheric vibration, previous excitation of the tube having rendered it sensitive to such an etheric influence. Mr. Hammer also refers to his observation of the lighting up of a vacuum tube with apparently no exciting cause, which phenomenon has also lately been observed abroad. Both of these phenomena deserve careful study, for a complete explanation will not only be of the greatest interest *per se*, but may have an important bearing on etheric phenomena generally.

THE PROGRESS OF ELECTRIC LIGHTING.

Electric lighting has long passed the apologetic stage of its history. It has assumed an importance so commanding that it would be scarcely worth while if it were possible to recount the details of its forward march. But they have on the whole been of about the same kind to which we have been accustomed. The student of electrotechnics as a rule finds little of a sensational character striking his attention. Yet there are dominant tendencies even if no radical changes. In the power station there has been a steady and conspicuous increase in the use of turbo-generators, which must have a salutary effect upon station economy, and now the gas engine is coming forward for recognition. We do not here propose to raise the moot point of turbines vs. engines. That will have to be fought out by the champions of the respective machines in the arena of strenuous competition. But we do wish to point out that particularly in stations of moderate size the light load conditions, always a source of anxiety, are greatly ameliorated by the introduction of turbines. Whatever the ultimate economy of the turbine may be, it undeniably has very small friction losses, and these are what count in the evil hours when there is no load to speak of and the plant must still be kept in operation. In methods of distribution there is a steadily increasing use of alternating current as might be expected, but no striking advances save in output.

The most interesting feature of the year's advance is in the direction of new illuminants. Of these the most striking is the mercury arc, which now has begun to work its way into commercial use. Its color bars it for general use in interior lighting, although improvements are promised; but this very failing makes it extraordinarily conspicuous when used for advertising purposes, a legitimate and growing branch of electric lighting. A mercury arc stops the passer-by almost as effectively as a sentinel with a fixed bayonet at charge, and its capacity for bizarre effects gives promise of continued usefulness even after the original novelty has worn off. Some very interesting experiments on its application to street lighting have been tried during the past summer, and the verdict seems upon the whole to be rather favorable, particularly where incandescents or widely spaced arcs would otherwise be used. A useful technical field has begun to develop in the application of this light to commercial photographic processes. In blue print shops and in photoengraving work the new light has already proved its usefulness, and a more recent application is in the printing rooms of photographic studios. It is found that platinum prints can be very quickly and conveniently worked off by the mercury arc, which is a great convenience in dull winter weather.

The arcs with composite electrodes of various compositions have also passed from a mere laboratory existence to tentative use outside,

and while the results cannot yet be called decisive they are at least encouraging. As is probably known to our readers, some arcs of this class have given by far the highest efficiency yet attained by any artificial illuminant, even as high as four or five candle-power per watt, and the color effect is excellent. A certain tendency to smudginess seems to be the chief objection to the class in its present stage of development, but how serious this really will prove to be one can hardly say. Certainly the hope of so great efficiency will spur on experimenters to determined efforts. It is even reported that an out-and-out vacuum tube lamp is ready to pass from the experimental to the tentatively commercial stage, but this can hardly belong to the past year's record. The Nernst lamp itself, by no means now a novelty, has been quietly pushing its way into more considerable use and it really looks as if by another year the new illuminants will begin to cut some figure in the statistics of the art. Our old friends, the incandescent and the enclosed arc are still, however, doing business at the old stand and will not put up their shutters at the rumor of competition.

TESTING LARGE ALTERNATORS.

The rational design and construction of alternating-current generators depends upon the accuracy with which machines can be subjected to tests and experiments by which their properties and their behavior under different loads can be ascertained. It is not sufficient to be able to test machines after they are installed, because it is not only desirable but essential for the manufacturer to know whether the machine meets the specifications before it leaves the shop; and as usually the machines are put into service immediately after installation, the station engineer is loathe to sacrifice time and expense for tests which to him appear unnecessary and useless, being satisfied if they do the work for which they were intended. Now, it need hardly be remarked that a machine may well answer the requirements of a station without meeting the specifications according to which it was to be designed. With increased competition, it becomes incumbent upon the consulting engineer to satisfy his client and himself that the machines purchased are actually in accordance with the specifications, and that they do not evade some of the points at variance with the manufacturers' standard shop practice. It is from such considerations of the commercial importance of accurate tests on large alternators under full load conditions, and from the engineering interest of such tests, that the matter of testing large alternators is deserving of the most careful attention.

The primary points to be ascertained in the testing of alternators are the heating of the armature core, armature and field coils, and the regulation of the generators, under all possible conditions of load. Small alternating-current generators, up to 200 and 300-kw capacity, can generally readily be tested in the testing departments of the large manufacturing concerns. There are in most cases machines available of approximately the same output and voltage which can be operated as synchronous motors from the generators which are to be tested. If two machines of the same size and type are available, a test can be made on them which is a logical extension of the principle of the method of circulating power, originated by Dr. John Hopkinson in 1886 and applied to the testing of a pair of direct-current machines. While in Dr. Hopkinson's test of direct-current machines the relative position of the two armatures, which are rigidly connected, is immaterial, in circulating power between two alternators, it is this relative position of the two armatures or the two revolving fields which determines the power circulated. The greater or less difficulty in setting up two alternators and connecting them rigidly at a certain angle has limited the application of this method in practical work. Mr. William M. Mordey suggested in 1893 the feasibility of circulating power within a single machine. The Mordey alternator had a single rotating field coil, and the armature consisted of radial projecting coils, which were connected in series. By connecting more than one-half of the armature coils in series with the remaining coils, Mr. Mordey succeeded in circulating wattless current through the armature.

Applying the principle of this ingenious suggestion to the modern revolving field alternator, we have, in addition to Mordey's method of connecting armature coils in opposition, the other possibility of leaving the armature connected in series and of connecting the field coils in opposition, so that a larger number of field coils opposes a smaller number. While there is no theoretical flaw in this arrangement, the method becomes in actual practice impossible on account of the unbalanced magnetic pull produced by the armature current strengthening the fields that act as motor, and weakening the fields that act as generator. To overcome this difficulty, it has been suggested to split the revolving field into four sections, so as to distribute the disturbance uniformly over the circumference. This method seems to be but a make-shift requiring a number of connections inconvenient to make, and involves four places on the periphery of the armature at which the distribution of magnetism is different from normal. It has, moreover, the main disadvantage that the maximum induction to which the core is subjected is not the same as that in the generator when running. Another method consists in connecting the two halves of the same number of coils of the field in opposition, each half carrying the same current. There will thus be no e.m.f. generated in the armature coils, and by supplying direct current equal to the full-load current of the alternators, the current losses in the armature can be made up. In a polyphase generator tested in this manner, the direct current flowing through the armature coils produces a magnetic pull which is stationary, whereas the magnetism of the revolving field rotates with an angular velocity corresponding to the frequency of the alternator. The revolving field, therefore, with the closed exciting circuit and other closed circuits as field collars and dampers, cuts through this stationary armature field, thus leading to additional losses of a magnitude which cannot be calculated. This method, therefore, does not recommend itself, especially if we bear in mind that the accompanying conditions of armature reaction are altogether different from the actual working conditions of the generator, although it is possible by changing the connections of the armature to destroy almost completely this armature field.

Neither of the above-mentioned methods of testing large alternators permits the determination of the regulation. A modification and improvement of Mr. Mordey's method has recently been suggested by Mr. Behrend. Mr. Behrend's method consists in dividing the field of a revolving-field generator into two opposing halves, and in using different exciting currents in each half. The armature of the generator is short-circuited, and therefore no special connections have to be made excepting a lead from the common point of the field to the shaft or to a slide ring thereon. The advantage claimed for this method is its simplicity and the accuracy with which the full-load conditions are represented by artificial conditions. The experiments seem to have established the fact that the core loss in this method of testing is equal to the core loss under full load, and to the core loss on open circuit for the same terminal voltage. The method is also applicable to the determination of the regulation, as the conditions of armature reaction are almost identical with the conditions under full load at a power factor of zero. Excepting the disturbances produced on a diameter by the opposing fields, there is no difference between the actual conditions and the artificial conditions for a power factor of zero. In machines having many poles, the error produced by this disturbance on a diameter

is negligible, but it becomes considerable in machines in which the number of poles is less than eight. On all machines the testing of the regulation by this method is limited to the regulation for a power factor of zero.

Mr. Mordey suggested in his paper of 1893, "On Testing and Working Alternators," to supply the current in the armature from an external source. An improvement on this suggestion is found in Mr. Burnand's method, which we publish in this issue. Mr. Burnand divides the armature circuit into quarters so as to abolish the unbalanced mechanical stresses, and he forces alternating current of the same frequency as that of the generator through the armature coils. It is plain that in this manner the relative phase of the armature current in regard to the revolving field can be adjusted. The method, however, does not seem to be free from defects. In the first place, the number of field disturbances is again increased to four, and in the second place, the method is rather difficult to carry out in the testing room. It must be remembered that most commercial alternating-current generators are polyphase machines, and the splitting of the armature coils is a rather inconvenient operation. The field disturbances must affect the determination of the regulation, and, therefore, this method appears to have no advantage over that of Mr. Behrend, excepting that there are four field disturbances in Mr. Burnand's method, against two in that of Mr. Behrend. With the advent of the steam turbine generator, the number of poles in large units will be greatly reduced, and while 60-cycle engine type generators for 3,000 kw and 75 revolutions have 96 poles, the coming turbine generator has for the same output only 12 poles. For 25 cycles an engine type generator of this capacity has 40 poles, while a turbine generator has only 4 or 6 poles. The methods of test, therefore, which have been developed for large alternators of the slow-speed kind, will have to be adapted to the high-speed generator, and new methods originated which permit the satisfactory testing of high-speed alternators under full-load conditions. Meanwhile, all the various methods proposed will be put to test and the method which survives will finally be recognized as the fittest for the manifold conditions that must be satisfied.

THE INTERNATIONAL ELECTRICAL CONGRESS OF ST. LOUIS THIS YEAR.

Now that we open the year 1904, the prospect of the International Electrical Congress enlarges and takes definite outline. The evidences are gathering to show that the success of the Congress will be marked. The number who have in writing already accepted membership in the Congress is over eight hundred. European engineers are now being invited to join. Until quite recently the invitations to join the Congress have been restricted to Americans, in order to make sure that a fair start could be obtained before asking foreigners to participate. It is not to be expected that a very large number of foreigners will attend the St. Louis Exposition or the International Congress, but it is quite likely that a number of European electricians will naturally desire to join the Congress in order subsequently to secure copies of the *Transactions*, since these *Transactions* already promise to have great electrotechnical value, and the expense of obtaining them independently at a later date is naturally liable to be greater than by original adherence to the Congress.

Some of the best electricians in Europe have already promised to contribute papers to the sections in September, and all of the papers to be read are to be by special invitation. The result of this policy of the Committee of Organization should be to produce at least as fine a set of papers, discussions and transactions for electricity as the Physical Congress of Paris in 1900, whose volumes have world-wide recognition as marking the universal knowledge and status of each branch of physics at the end of the nineteenth century. A number of prominent American writers have also promised to contribute papers, so that the representation that America can offer in the world's electrical knowledge and applications is not likely to be deficient. The State Department at Washington has also promised to espouse the cause of the Congress, and is believed already to have taken action on the invitations of foreign delegates.

There now remains to arrange the details of the plans of co-operation with electrical organizations who may desire to participate in the Congress, collectively as societies or associations, as well as individually through their respective members. Notably this is the case with the American Institute of Electrical Engineers whose membership has a large representation in the Congress, and whose president is the chairman of the Executive Committee of the Committee of Organization of the Congress. Ten members of the Board of Directors of the Institute are also officially connected with the Congress. It is hoped that the Institute, which is interested in the work of most of the Congress sections, may take an official representation in the Congress and participate in the proceedings. Invitations are being forwarded to various other physical and electrotechnical societies, asking them to join in the official representation and participation at St. Louis. It is, therefore, to be hoped that the proceedings of the Congress will represent the best available papers, and also the best available work of individuals and of societies, scientific, electrochemical, electrical engineering and electrotherapeutic, all over the world. Ample accommodation has been promised within the precinct of the Exposition for the Congress. In fact, the accommodation offered will not only be ample for all the Congress sections working simultaneously, but also for such other electrical organizations as may desire to hold a convention in St. Louis simultaneously with the Congress.

THE PROGRESS OF ELECTRICAL THEORY DURING 1903.

No noteworthy discovery in electrical theory has received prominent notice during the past year, but steady progress in electrical science has been made. In particular, the electronic theory has steadily advanced. That is to say, the theory is gaining ground steadily that electricity is indissolubly connected with the component parts of an atom of matter; or, what may be the same thing, that atoms are composed of electricity, or are disturbances of ether corresponding to minute electric charges. Every year that passes extends the scope of the science of electricity, which is only another way of expressing the fact that the various sciences are approaching unification. Optics became a department of electricity when, by the labors of Maxwell and of Hertz, the electromagnetic theory of light was established. Similarly, there is now laid in the electronic hypothesis a basis for an electrical theory of matter in general, and of dynamics in particular.

It is by no means yet clear that the inertia of matter, the inertia of a billiard ball, for example, is due to the self-induction of electricity in the ball, and the opposition which self-induction sets up to an electric current or moving electric charge. But it now seems to be clear that there are large aggregate electric charges bound up in some intro-molecular way with the ivory or composition, of which the billiard ball is formed. It is also known that such electric charges must resist being moved or stopped, by the self-induction law, according to the same law as mechanical inertia; that is to say, according to the second differential of the distance with respect to time; or, in ordinary language, in proportion to the acceleration. There seems, therefore, to be no escape from the proposi-

tion that at least a part of the inertia displayed by a billiard ball is due to self-induction. The real question is whether there is enough electricity, on the whole, in the matter of a billiard ball, to account for all of the inertia. An electrified pith ball, for instance, is supposed to have a small amount of extra inertia, due to its electrification; but so little extra, that it has never been made evident. The total charge stowed away molecularly in a billiard ball must be immense, in order to account for all of the inertia electrically. If all the atoms carry the same charges that they carry in electrolytic processes, the electrical share of the inertia of a billiard ball would seem to be very minute. But if, according to the electronic theory, there may be numerous electrolytic atomic charges stowed away in an atom, then it would be possible to account for all of the inertia by self-induction.

The suggestion is strong, therefore, that dynamics is now a department of electricity; or that electricity is a department of dynamics; or that there is no longer any fundamental division of science into electricity and into dynamics; but that both are branches of a yet more fundamental knowledge, bringing to mind the time-honored remark of the French King to his son departing to ascend the throne of Spain: "The Pyrenees no longer exist." The signs of the times are that in this way each science will extend over the borders of its neighbors, until, when it has conquered them all, it will have destroyed itself, and all the sciences will be one and the same. This tendency to merging unification and desectionalizing is steadily pervading every human interest.

RECENT ELECTROCHEMICAL DEVELOPMENTS.

Under this title we have presented weekly concise analyses of current electrochemical patents, which latter collectively may be said to represent the only available authoritative literature on the newest developments in this branch. On the other hand, in electrochemistry—as in other departments of applied science—patent specifications are apt to represent rather the inventor's hopes than real accomplishments. A summary review of the present actual condition of the electrochemical industries may, therefore, not be without interest at the present time. The year 1903 has not witnessed any developments on remarkably novel lines, yet there has been a very considerable activity, and conscientious and persevering work along certain lines has resulted in some new additions to the art and considerable improvement in some of the established branches. Thus in electric furnace work, the apparently very simple reaction between silica and carbon in a furnace became with Acheson the starting point for the gradual development of the industries of carborundum, artificial graphite and more recently "siloxicon." The principal point established is that the decisive factor determining the product of the reaction is the temperature. While at the time of the advent of the electric furnace the desideratum was the production of the highest possible temperature, now the end is so to design a furnace that the temperature can be held uniform and can be exactly regulated within given limits. Acheson's siloxicon furnace and Tone's silicon furnace illustrate this development during the past year.

In one special line the electric furnace has made important advances, especially in Europe, and that is the metallurgy of iron and steel. It is true that we have here but the beginning of a development, but it is a branch which promises to become of great importance. At present ferro-alloys and special steels are commercially made in the electric furnace, and there is a greatly increased interest in the electric furnace metallurgy of rare metals. It is in the manufacture of the most expensive special steels that electric furnace methods appear to have the best prospect, and it seems probable that in a few years "crucible steels" will no longer be made in crucibles. One of the chief advantages of the electric method is easy control and cleanliness, there being no contamination from the fuel gases. In this connection it is interesting to note how electrochemical inventors strive to avoid contamination from the presence of carbon electrodes. Heroult and Keller use carbon electrodes which do not reach into the fused metallic mass, an arc jumping from the carbon to the mass and another arc back from the mass to the other carbon—a slag at the top of the mass protecting the fused steel from contamination. Kjellin is still more radical, since he dispenses any electrodes entirely, his charge forming the secondary of a transformer. The developments in this line are of particular interest to the electrical engineer owing to the bearing on the production of steel with special magnetic properties.

While the calcium carbide industry continues in a satisfactory state, its expansion depends upon increased uses of acetylene, and in this the development is somewhat slow. In this connection we may recall a remark of the late Luther Stieringer, who expressed the hope that, owing to the beauty of its light, he might have an opportunity to light an exposition with acetylene. The aluminum industry being now relieved of the uncertainty of status existing during the long patent litigation recently closed, is now in a position to strike out more vigorously in new directions. The use of aluminum for electric conductors increased largely during the past year, and its employment as a reducing agent in metallurgy for producing very high temperatures locally and almost instantaneously, has been developed by Goldschmidt into a new branch of engineering, aluminothermics. The electrolytic production of metallic sodium and potassium continues to increase annually, and their use is largely extending in the cyanide process of recovering gold. In this country the precipitation of gold from cyanide solutions is still mostly done by zinc shavings, but the electrolytic method continues predominant in South Africa. The production of caustic soda and bleaching powder by electrolysis of sodium chloride has become a very extensive electrochemical industry and in this field the new electrochemical methods have attacked, and in some cases finally conquered, old and firmly-established chemical industries. The variety of this electrochemical method is well illustrated by the fact that three essentially different processes are commercially successful in the same field in this country, namely, the Castner-Kellner mercury cathode process, the Acker process for the electrolysis of fused salt, and the diaphragm cell process. Unfortunately, the market is utterly demoralized at present, and the hope for better conditions rests in a mutual understanding concerning selling prices now said to be under consideration by the manufacturers.

An interesting development in the New England States is the installation by the larger paper and pulp mills of their own electrolytic plants for making the bleach required in their works. The general use of apparatus for making hypochlorites or bleaching liquors, while increasing in Europe, has not made much headway in this country, although it should here have a good future in bleaching finer linens and in laundries. In refining copper this country easily ranks first, and the industry is in prosperous condition. The United States now produces 85 per cent. of all the refined copper of the world. A very promising beginning in the refining of lead has been made in the Betts process, and gold is being electrolytically refined in the Philadelphia Mint. There is little doing commercially in the electrolytic production of metals from their ores, although the Browne process, which has been successfully used for several years in Cleveland for separating copper and nickel from the Sudbury ores, will be employed on a larger scale by the International Nickel Company upon the completion of a new plant now under way. In electroplating—the oldest branch of electrochemical engineering—

there is to be observed a pronounced tendency to get rid of the old rule of thumb, which has afflicted this particular industry to an extent that greatly handicapped its progress.

Perhaps the most interesting development in electrochemistry has been with respect to processes involving electric discharges through gases. The production of ozone from air and the use of ozone for sterilizing water have proven successful in Europe; whether they will obtain commercial importance in this country is simply a matter of dollars and cents, but the technical difficulties may be considered to have been overcome. The most promising development in this line is, however, the Bradley process for the fixation of atmospheric nitrogen, although no new developments have been recorded concerning it during the last year. In the battery field there has been again great activity, though confined principally to the patent office; and as in the past, but few of the inventions in this line there recorded give promise of any future. The lead accumulator's position seems assured as an auxiliary for light and power purposes. On the other hand, the future of the belated Edison nickel-iron accumulator seems very bright for automobile purposes. The old dream of electrochemical inventors of a carbon cell that will revolutionize the generation of electrical energy still remains a beautiful dream, and it is with regret that we have to state that there are no signs yet that it will soon be realized in practice. If aspiring inventors in this line would, before commencing to invent, make themselves thoroughly acquainted with the role that thermodynamics pl ys in electrochemical action, much waste of effort would be spared—and no inconsiderable sensational copy lost to the newspaper press.

A YEAR OF EXTREME RADIOACTIVITY.

No branch of physical science has, in the last twelve-month, been prosecuted—we had nearly said persecuted—with so much vigor as the investigation of the curious phenomena of radioactivity. The greatest interest has naturally centered about the remarkable discovery of Mde. Curie that radium salts seem able normally to maintain a temperature slightly above their surroundings—that is, they give out heat spontaneously to a very perceptible amount—and several of the year's researches follow directly along this line. As a preliminary to any discussion of this curious fact, it is well to remind the reader that in nearly all the popular articles and many scientific ones, radium is a word used to denote not the metal of that name, but its chloride or bromide, generally the latter. In a similar slipshod fashion the photographer sometimes refers to the silver in an emulsion, meaning thereby the bromide or chloride of silver. Radium, the metal, is as yet unknown, although a pretty good guess may be made as to its more general properties, but whether it is itself radioactive remains to be seen. So when the statement is made that radium decomposes or gives off emanations, or rays, it is wholesome to remember that the bromide of radium, generally quite impure, is the substance having these properties. As to the amount and character of the impurities referred to, it would be unwise to hazard a guess. Madame Curie, like her distinguished husband, is far more cautious and conservative in statements about radium than those whose knowledge is derived merely from a few decigrams of the stuff in a sealed tube. Her study of the atomic weight of radium showed steadily increasing values, for preparations of increasing purity up to her last figuring 225. Some rather reliable spectroscopic evidence indicates an atomic weight exceeding 250, so there is good reason to suspect that even the purest radium bromide yet obtained is by no means pure in the chemical sense, while the best commercial preparations are of much lower quality.

The spontaneous evolution of heat from radium is far from having a satisfactory explanation. The hastily jumped-at conclusion that radium breaks up into electrons with evolution of energy in enormous amounts, is hardly in accord with the physical and chemical stability shown by the spectroscope, and in the preparation of the substance. We fancy that as time goes on less and less will be heard of computations regarding the stored energy of radium in kilowatt-hours per milligram, and of the spontaneous formation of radium out of nothing in particular required to account for its continued existence. The hypothesis of Madame Curie, reinforced by Kelvin, that radium receives radiant energy of a kind usually neglected and gives it out as heat, is much more nearly in line with the ordinary facts of physics, but must wait for its proof until various problems in obscure radiations have been solved. The striking and beautiful work of M. Blondlot on the N-rays bids fair to throw much light on this phase of the subject, since these rays present many of the attributes of radioactive emanations and yet obey the ordinary laws of radiant energy, being reflected, refracted and polarized in the usual manner. The recent announcement that radium gives off an emanation that acts like a heavy gas (or is one!) which later spontaneously decomposes with probable evolution of heat and certain evolution of helium is, from a purely scientific standpoint, of much greater importance than even the thermal anomaly just discussed. The first chemical step toward the comprehension of an unknown substance is its resolution into known products of decomposition. Of course, in the case before us the next question to be asked is with what the resultant helium was combined to form the heavy gaseous "emanation." We do not like this word emanation—it smacks of the days of "caloric" and "dephlogisticated air." If impure radium bromide gives off a heavy, unstable gas, why not state the fact in so many words? The immediate inference, that radium must be regarded as a condensation of helium, is immensely important—if true.

The first step toward a proof would be to show that the heavy gas is a condensation and not a compound of helium. The spectrum of this gas is reported as of unknown character, but should, on investigation, show its kinship to helium or to something else, and thus answer the question one way or the other. Certainly the present evidence is a very slender foundation for the announcement of the transmutation of elements as an accomplished fact, although we believe that at least one stock company for modern alchemy is already being exploited on the strength of it. Unhappily, radium is extremely scarce and separated only with great expense, so that it is at present almost impossible to study it by ordinary chemical methods. Possibly pending a better source of radium a concentration of attention on thorium, which is far more accessible and has very similar properties, would tend to the advancing of our knowledge of radioactive phenomena. Radioactivity as such, now that attention has been called to it, seems to be a rather common thing, so common that it is hazardous to conclude from its appearance that any of the well-known radioactive substances are concerned in the phenomenon. It may even turn out that one should think of radioactivity as merely a quality rather than the result of the presence of an unusual substance. Experiments with the metals which furnish radioactive salts are likely to be of particular value in settling questions of this sort. Experiments like those of Baskerville, who found that radium was greatly increased in activity by mixture with a powdered natural silicate of zinc, are also likely to be fruitful. Radioactive substances have been studied too exclusively from the electrical standpoint, and the important advances of the past year have been notable for the wholesome tendency to seek other kinds of evidence and to study the phenomena by the light of other branches of scientific research. The facts are now being accumulated rapidly, and we hope before another year is passed that generalizations of some value will be possible. And we are disposed to think that the whole subject will be greatly simplified when the phenomena are seen in their true relations.

The Government Printing Office—The Electrical Equipment of the Largest Printing Office in the World.—I.

INTRODUCTORY.

NOT only with respect to external dimensions and floor space, but in regard also to number of employees and extent of output, the Government Printing Office at Washington, D. C., is fully entitled to claim the distinction of being the largest printing office in the world. The American love of mere bigness is gratified in every figure that one can cite about it, while in equal degree the American passion for doing everything by machinery and mechanical appliances is manifested there in every respect save one, namely, the use of typesetting machines—but that is another story. To the visiting electrical engineer it is more than gratifying to note how with remarkable boldness, but with corresponding judgment and discretion, electricity has been called upon to discharge all the vital functions of light and power, as well as to furnish heat in novel and convenient manner. The display of the flexibility and resourcefulness of electricity in all parts of the plant is, indeed, a fascinating study. The work here done is done in such a way that he of all men whose heart it would most have rejoiced was at once this country's typical printer and pioneer master electrician—Benjamin Franklin himself.

FIG. 1.—VIEW OF THE EXTERIOR OF THE GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

Standing in a section of the city that is otherwise devoid of large buildings, the Office looms up in dominating proportions that gain by the clear vistas, and its huge red pile is a notable landmark of the National Capital. Many of the public offices in Washington suggest by their exterior a bureaucratic nature and a devotion to clerical work; but whether by design or not, the Printing Office wears a utilitarian air that well befits it without marring its quiet and unostentatious dignity of aspect. The building of red brick, with terra cotta and sandstone trimming, has a front of 175 ft. on North Capitol Street and a depth of 408 ft. on G Street, and has a height of seven stories, exclusive of deep basement and loft. It is nearly a hollow square, as shown by one of the floor plans in this article, so that the interior spaces of the vast area get their share of outside light. All told, there is not less than eight acres of floor space, and of this six acres is available for actual working purposes. The interior court is 30 ft. wide and 167 ft. long, and the power house at the northwest corner completes the rectangle. The framework is of steel, over 12,000,000 pounds having been employed, and the stories all 16 ft. apart from floor to floor, with an approximate distance of 12 ft. from center to center of the window spaces. The iron and steel structural work is covered chiefly with fire brick, and the substratum of all the floors is brick and concrete. Upon this in working areas is generally laid 1¼-in. maple flooring; and there is 210,000 sq. ft. of wood-block floor, 300,000 sq. ft. of cement floor, and 15,000 sq. ft. of tile and mosaic. The main entrance on North Capitol Street is of richly ornamental character in gold, tile, mosaic and marble panelings and stairways, with a pedestal at the main stair flight to be occupied in all probability by a heroic bust of Franklin. It is at this point that interior decoration is concentrated, and but a few steps away everything is sternly and severely strong, for use, not show. There are numerous wide halls and stairways throughout the building, all strictly fire-proof, in steel, slate, etc., and there are over a dozen elevators which also afford means of entrance and exit for the 4,000 employees under Public Printer Palmer's administration, as well as for the vast quantities of material handled. It is quite needless to emphasize, even in passing, the necessity even on an ordinary basis, for careful and elaborate plans of wiring in advance; but it must be borne in mind that almost on every floor of this solid, rock-ribbed construction special circuits have had to be run to some piece of apparatus or line of machines. Hence, for complexity of distribution, it would be hard to match the building under consideration, whose daily consumption of current compares with that of many a large central station system.

In dealing with an institution of the scope and character of the Government Printing Office, it is impossible to bring to notice, and undesirable to do so, many features of great interest; and the present article is necessarily restricted to topics falling within the purview of this journal. But in order that the reader should understand

what electricity is called upon to do, certain items must be noted before a detailed description of the plant is taken up. The data are perhaps unrelated, but all bear upon the subject. At first glance the annual expenditure of $6,500,000 annually here on government printing may seem fabulous, but a brief analysis of the work done and stock carried by the Office reveals conditions and capacity that attest the extraordinary practical importance of the plant as one of the elements of national diffusion of intelligence. When we find over 4,000 employees, to say nothing of visitors and business callers, we appreciate the necessity for the 8 electric passenger elevators, all of which could handle the whole crowd from the first to the top floor every twenty minutes. When we learn that the annual consumption of paper, for book printing alone, is 100,000 reams flat, and 110,000 reams in rolls; that 3,000,000 sheets of Bristol and cardboard are used; that 1,700 reams of cover paper, 35,000 reams of writing paper, 1,700 reams of typewriter paper, 4,700 reams of manila and tissue paper, and 10,000 reams of coated book paper are used up each year—then we grasp the utility of the five big freight elevators, all electric. One of these at the sidewalk, to carry paper from basement to first floor, will lift 6,000 pounds 100 ft. a minute. Another of the freight elevators has a capacity of 10,000 pounds 150 ft. a minute. The other three will each handle 5,000 pounds 350 ft. a minute. It will be seen at once that the Office in elevators alone has the capacity of a good-sized electric railway for passengers and freight, and needs it all.

Looked at from the other standpoint of output, and disregarding the other items of work within the Office as a self-sufficient organism, it will be seen that the data are again extraordinary. A consumption of 30 to 35 tons of paper daily on the presses all run by electric motors tells the story in one way. The fact that 700,000 volumes of departmental reports are carried in store, ready for distribution, tells it in another, for each volume has to be composed, proofread, printed, folded, bound, labeled and followed through to storage or to the proper depositories and channels of distribution. Then there are such incidental items as the *Congressional Record,* with a daily circulation of 23,000, while Congress sits, a single issue having reached 192 pages. The edition hereafter will run much higher, but the last copy must be off the press to catch the morning mail trains around 5.30 A.M. Such regular work is intensified by sudden demands for special printing required by Congress, to meet which all the resources of the Office are strained and the electrical plant is driven to its limit. The issuance of the famous report on the blowing up of the *Maine* is an instance. Consisting of 298 pages of text, 24 full-page engravings, and one lithograph in colors, and the manuscript being received at 6.30 P.M. one day, a copy lay on every desk in the Senate and House next morning at 10 A.M. As to the speeches of members of Congress printed in pamphlet form from the *Record,* they run into the tons and the millions. Moreover, there are other daily issues that must come out on time, hot from the press, as any "yellow," and even the United States Supreme Court has its daily with a select circulation of some three-score copies. Bills again use up a tremendous lot of paper and ink and electricity, for the passion to regulate everybody else by legislation never wanes, as evidenced by the ghastly fact that in last Congress there were printed 8,025 Senate bills and resolutions and 18,420 from the House, of which 1,384 became law, when at least one copy to be filed with the Secretary of State had to be printed by special motor-driven presses, on parchment. Every week the electrical field is brought into close touch with the work of the Office by the issuance from it of the electrical patents just out of the United States Patent Office and the weekly number of that Liebig's extract of invention, the *Patent Office Gazette;* while once and again come other reminders in the shape of Census Bulletins on street railways, electric lighting, etc. The Printing Office has had at one time 20 tons of fine type and rule work standing for the United States Census Office; while its ability to respond to calls for new editions, etc., is shown by its storage vaults under the sidewalks, with a capacity already pretty well occupied in the new building, for 2,000,000 electrotype plates, every one of which has been, or will be, made by the Office's own electrical equipment. Facts of this kind could be piled one on the other, column after column, but the data now quoted will probably suffice to illustrate at once the scope and quantity of the work accomplished as well as the absolute confidence placed in electricity as the actuating medium.

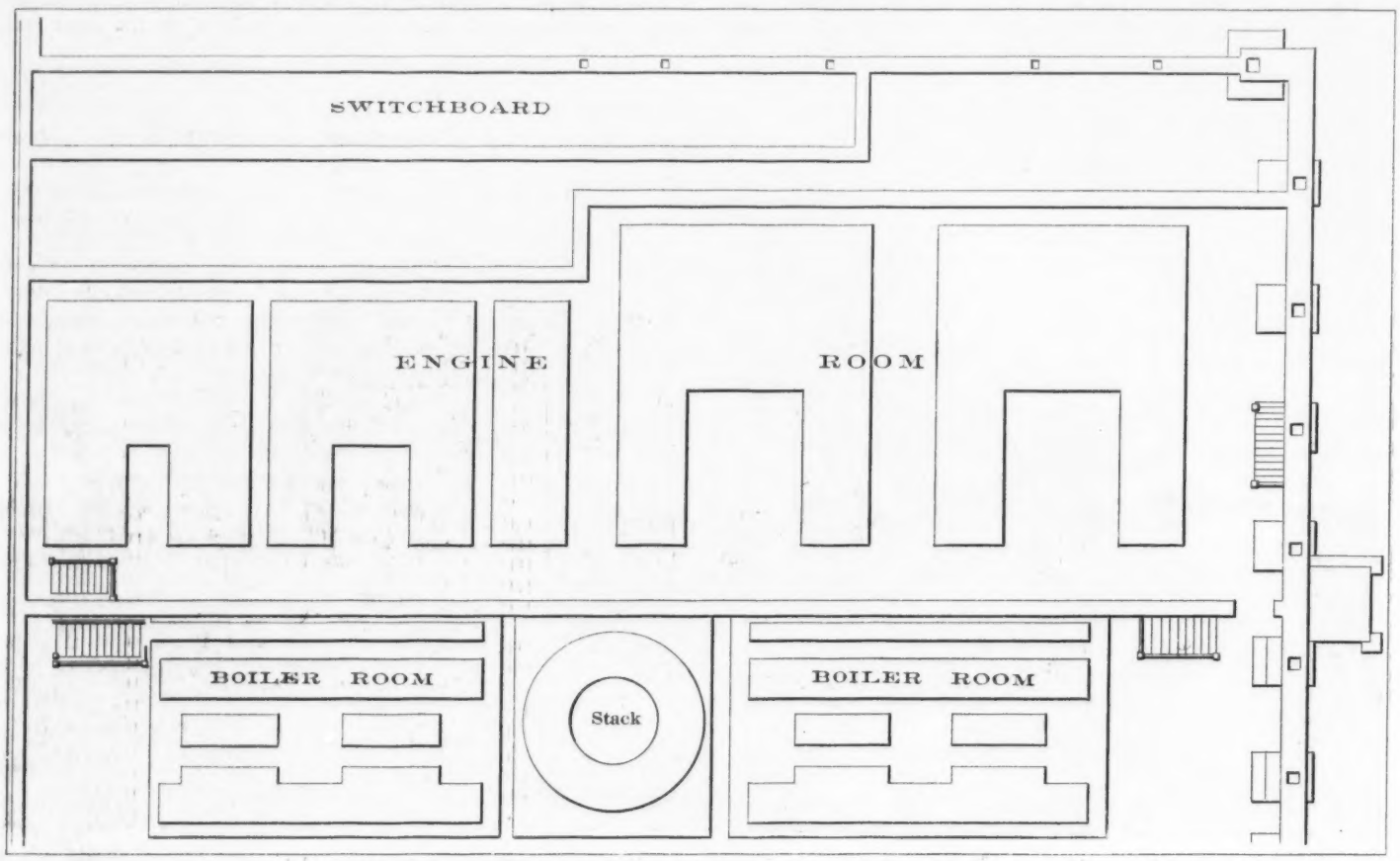


FIG. 2.—PLAN OF ENGINE ROOM, DYNAMO ROOM, ETC.

POWER PLANT.

The power plant of the Government Printing Office constitutes, as already noted, a part of the interior quadrangle, being flanked by the old and new wings, which together form the present establishment. The power house is a brick building 112 x 134 ft. in plan, and is divided longitudinally between the engine and dynamo room and the boiler room, as indicated by one of the line engravings herewith, which shows the foundation plans of the two sections and of

the stack. While in a sense of evolutional growth, the plant is essentially a well-planned unit as it stands. The first plant was put in some years ago in the old building, and proving successful, but outgrown, it was abandoned and a new power house was erected. The work of moving was a difficult undertaking, as it had to be done without interfering with the operation of the plant. It was effected, however, very smoothly by Mr. W. H. Tapley, the chief electrician and electrical engineer, and Mr. H. K. Collins, the chief engineer. The plant then installed was adequate to the requirements of the old Office and consisted of one 300-kw, 125-volt generator, running at 150 r.p.m., and one 125-kw generator of same voltage and speed, both dynamos being built by the Crocker-Wheeler Company, of Ampere, N. J., and both engines by the E. P. Allis Company, of Milwaukee. When extensions to take care of the new office came up, one of the most important problems was that of continuing the lower voltage or of adopting 250 volts. It was finally decided to adhere to the old pressure of 125 volts, and the additional contract was placed for two additional Crocker-Wheeler generators of 600-kw capacity, 100 r.p.m., and two Allis engines of corresponding

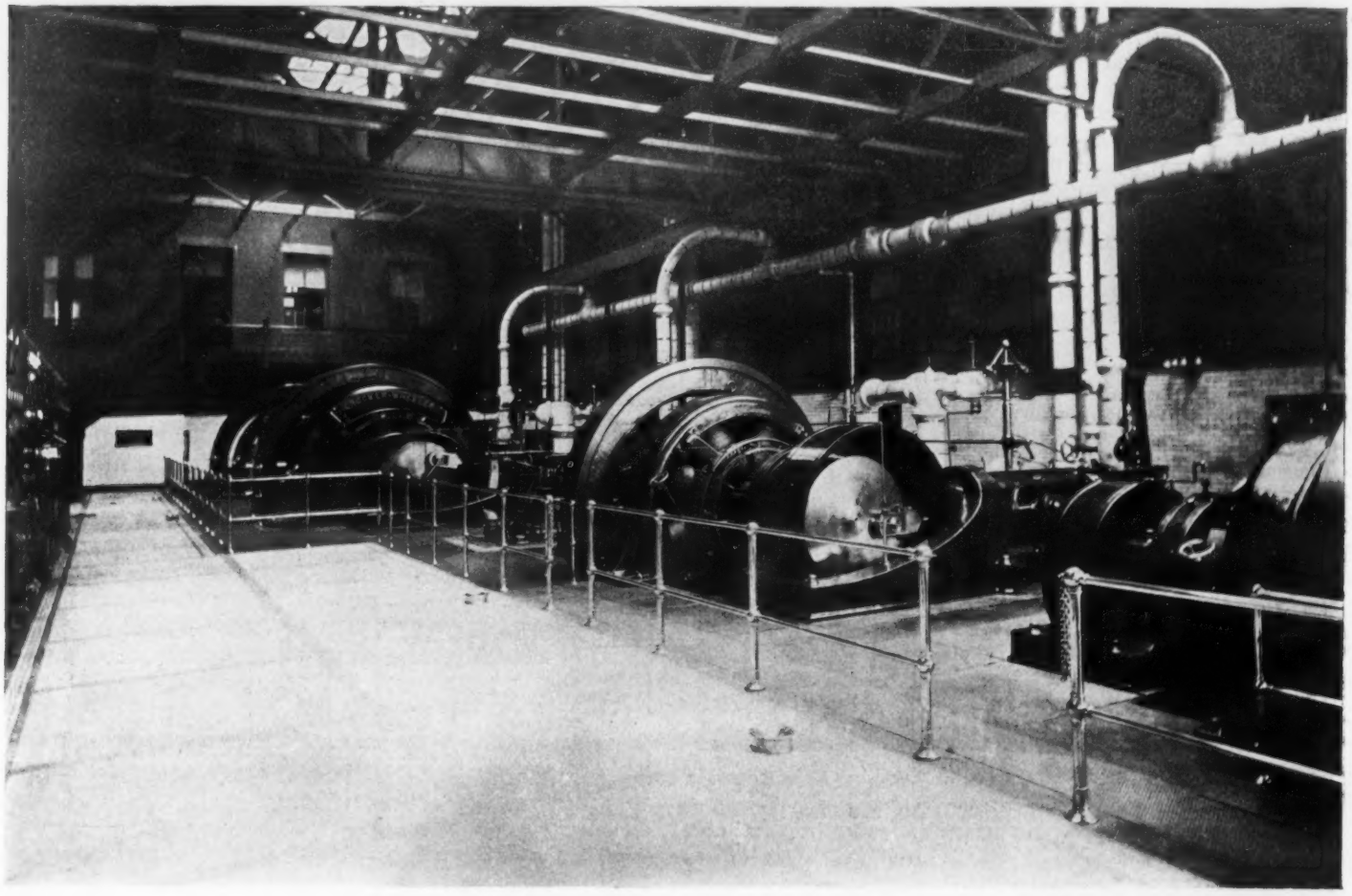


FIG. 3.—GENERAL VIEW OF ENGINE AND DYNAMO ROOM.

capacity. These generators, of the multipolar type, were required to be overcompounded 5 per cent. at full load, with series coils so proportioned as to overcompound by regular equal increments proportional to the output between one-quarter and full load, with a maximum variation at generator terminals not exceeding 1½ volts when running within 1½ per cent. of standard speed; this overcompounding being reduced in the regular operation of the plant to 3 per cent. by the use of German silver shunts in the service fields. The compounding is also so arranged as to permit the generator after having "built up" and when running at standard voltage, being thrown in circuit without taking any of the load or being reversed; and to run thus indefinitely, if necessary. The dynamos have a guaranteed efficiency of 94 per cent. at full load, and will withstand an overload of 25 per cent. continuously for four hours, as well as momentary overloads of 50 per cent. At 25 per cent. overload, the efficiency is 93½ per cent.

Special features of the machines are the internally-flanged frame, giving a very smooth outside appearance and great rigidity. The brush rigging consists of a circular cast-iron ring held in place by supports bolted to the frame and holding the brush attachment. The brush holders themselves secure the brushes by means of a box, one side of which is held tightly against the brush. Four sets of copper leaves carry the current from the brush box to the arm, and their position is such that the movement of the brush on the commutator is always radial. Hence, there is no necessity of changing the seating after the brush is once worn to place. The spiral spring with the thumbscrew attachment secures the proper brush tension, and the copper leaves, carrying all the current, relieve the spring of any such duty. In spite of the great capacity of the apparatus, its compactness is also a notable feature. The large air-gap tends to reduce field distortion and consequent sparking under heavy loads. The units have been in operation for several months and, as usual, they run very quietly and without heating.

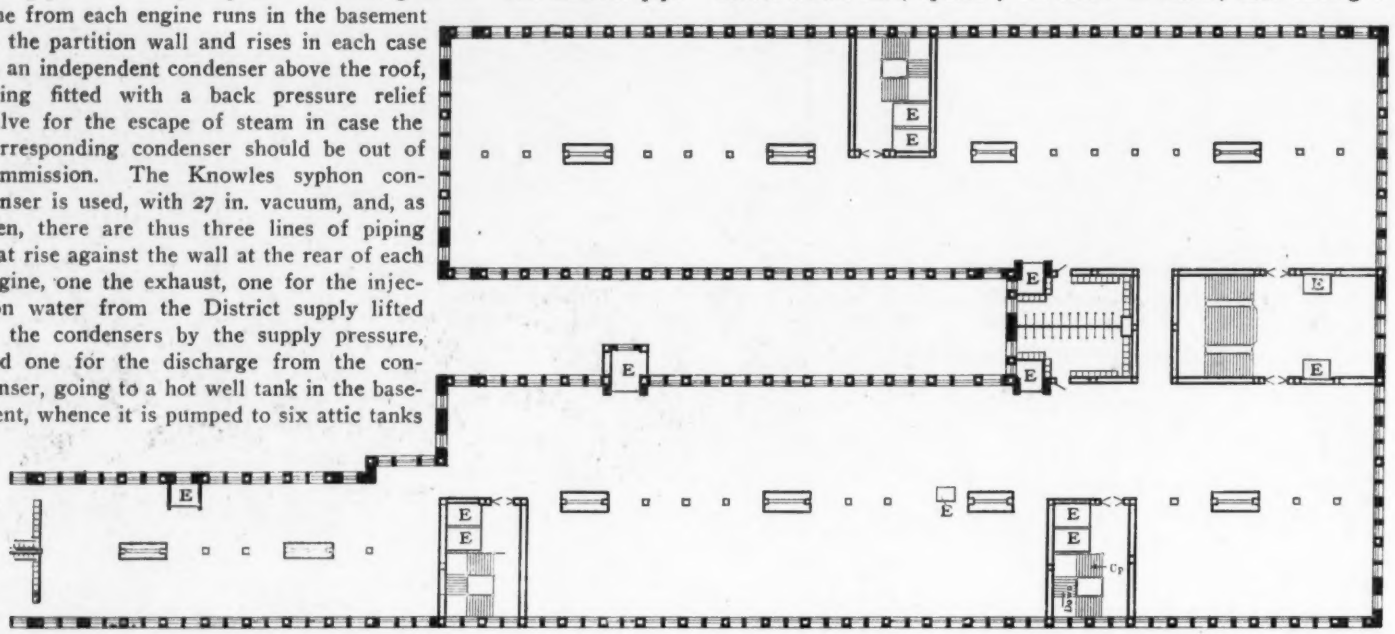
The four Allis engines furnished by the Allis-Chalmers Company are all cross compound direct-connected, the smaller ones being respectively 10 x 19 x 30 and 16 x 30 x 30; while the two new larger ones are of the same size, namely, 22 x 44 x 42. The small machines are arranged to run 150 r.p.m., and are supplied with steam at 125 pounds pressure, exhausting into Knowles barometric condensers. The engines are fitted with the regular Reynolds Corliss automatic valve gear, and have separate eccentrics for operating the steam and exhaust valves on the low-pressure side. The regulator is of the standard heavy weighted type, operating the cut-off cams of both engines, and having in conjunction a safety stop, which guards the engine in case of the breakage of the governor belt. A variation of less than 2 per cent. is guaranteed between no load and full load.

In addition to the governor belt safety stop, there is provided an extra governor which operates a stop valve placed above the throttle valve in the steam pipe, so that if the engine reaches a speed of five revolutions above normal, this valve is released and closes, thus shutting off all steam to the cylinder. In view of this relatively high rotative speed, the steam passages are liberally large, so that the velocities are kept low, and all wearing parts are also amply large for smooth and satisfactory operation.

The engines are fitted with metallic packing, and are adequately provided with oil guards and fittings for due lubrication and cleanly

operation. One of the requirements of the contract was a 30-day continuous operation without undue heating or wear of any part. A steam guarantee of 15½ pounds of water per indicated horse-power was also given when operating with steam of 125 pounds and a vacuum of 26 in. The normal rating of these two larger engines is 800 hp and of the two smaller ones 450 and 250 hp, respectively, so that the ratios to the dynamos are 1 to 1, 1.11 to 1 and 1.18 to 1, but it does not appear that the high rotative speeds of the small engines has militated against them in any way.

As will be noted by the engravings, all these handsome generator units are generously spaced with plenty of elbow room, within the brass rail that divides them off from the rest of the spacious hall and from the switchboard, a view of all being commanded by a broad gallery from which stairs run down to the main floor. Each generating unit foundation contains an opening by which an attendant can reach the anchor bearing plate and end of the bolt, and, indeed, the clear basement space affords freest access all around the foundations, which, by the way, are solid to a degree and remarkably free from tremor. The receivers between the cylinders of the engines are in the basement, but the piping connections of the low-pressure cylinders are, as will be noted, largely above the engine floor. The exhaust pipe between the high-pressure cylinder and receiver is also in the basement, but rises into the engine room, where the passage of steam to the low-pressure cylinder is controlled. The live steam connection to the low-pressure cylinder leads into this pipe and has a stop and a reducing valve. The exhaust pipe line from each engine runs in the basement to the partition wall and rises in each case to an independent condenser above the roof, being fitted with a back pressure relief valve for the escape of steam in case the corresponding condenser should be out of commission. The Knowles syphon condenser is used, with 27 in. vacuum, and, as seen, there are thus three lines of piping that rise against the wall at the rear of each engine, one the exhaust, one for the injection water from the District supply lifted to the condensers by the supply pressure, and one for the discharge from the condenser, going to a hot well tank in the basement, whence it is pumped to six attic tanks for house and toilet flushing, an aggregate capacity of some 4,000 gallons being thus furnished.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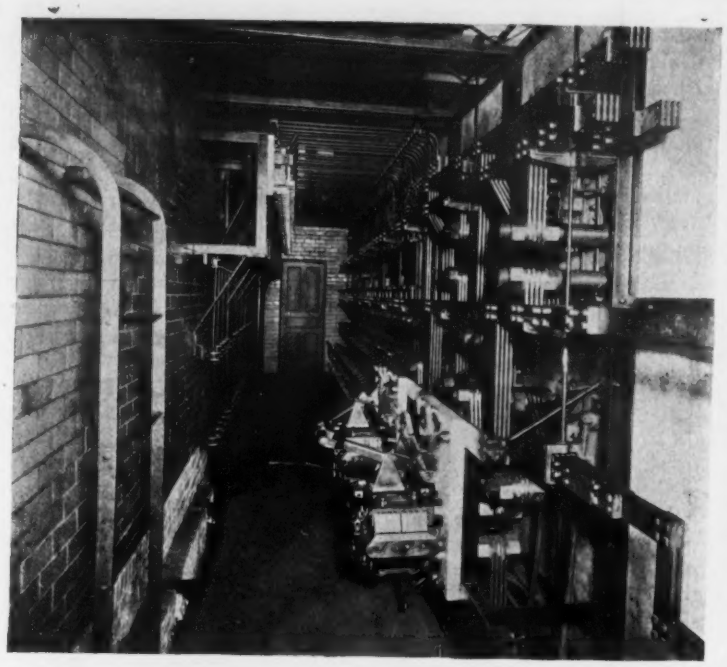


FIG. 5.—BACK OF SWITCHBOARD.

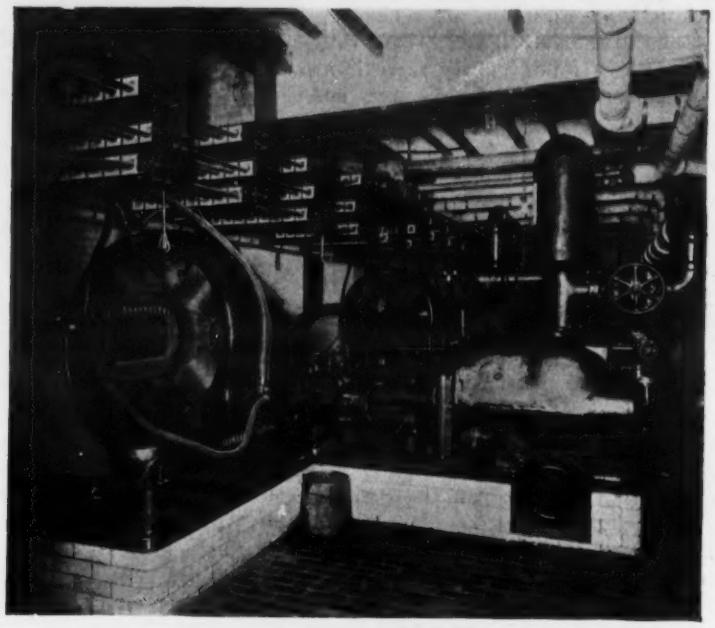


FIG. 6.—PUMPING OUTFIT.

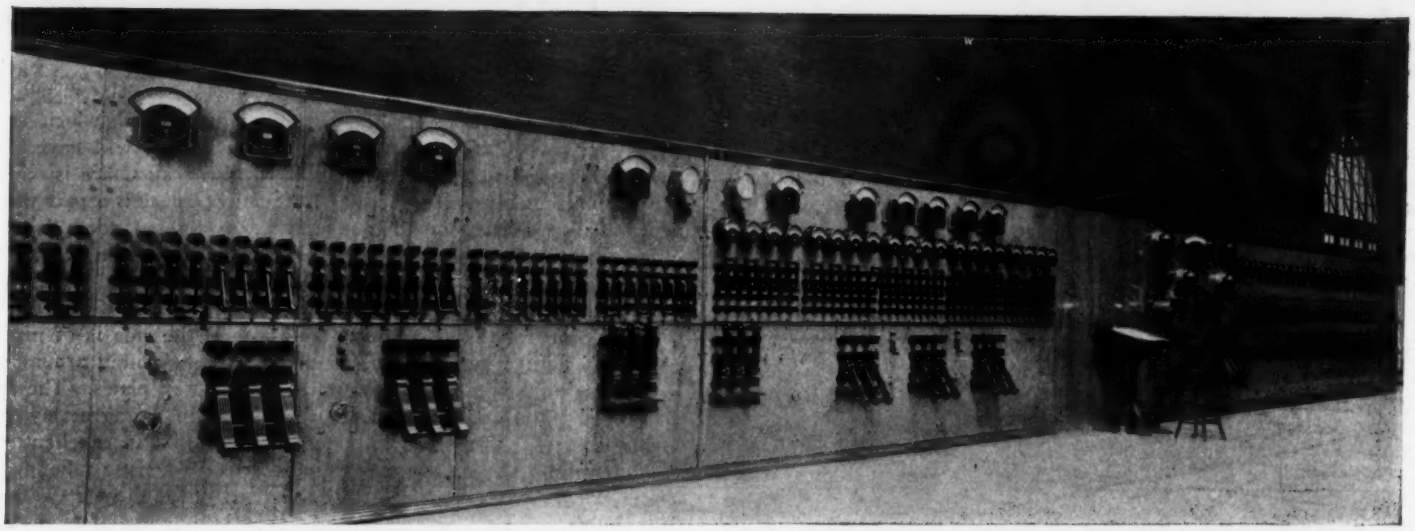


FIG. 7.—GENERAL VIEW OF SWITCHBOARD.

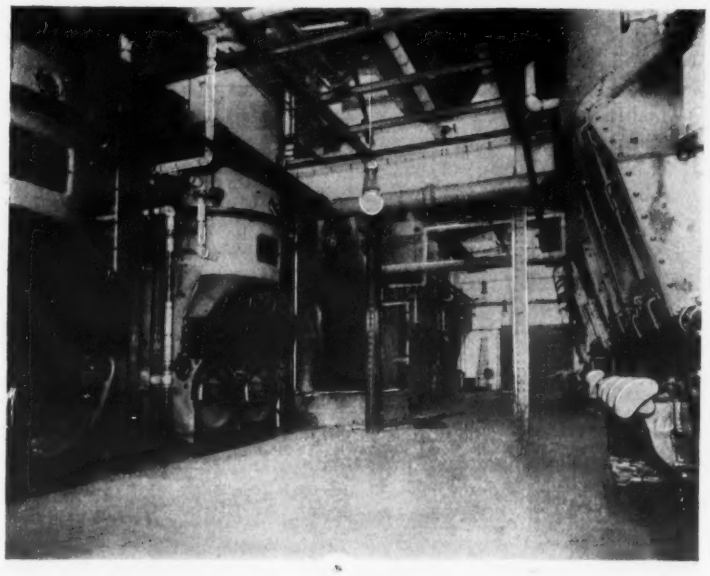


FIG. 8.—BOILER ROOM.

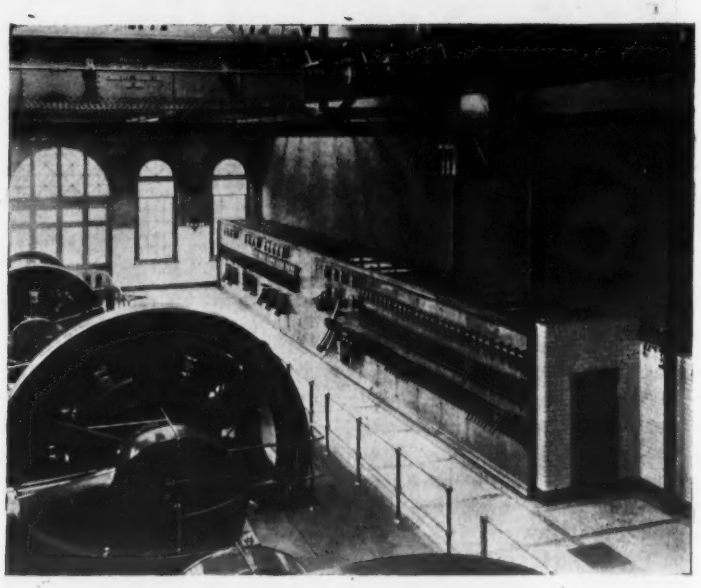


FIG. 9.—ELECTRIC CRANE, DYNAMO ROOM.

THE GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

of light galleries runs around the upper part of the boilers, giving access to the valves, which have their stems disposed vertically and upward. Of this gallery there is about 750 ft. The main steam outlet from each boiler connects into a horizontal main by means of a 180° bend of copper pipe, 8 in. inside diameter and 5/16 in. wall, with a single valve in the branch pipe. The main system of steam piping comprises two parallel lines of 12 in. extra heavy wrought iron, one line forming the steam header in the engine room and the other line running along the outside wall of the boiler room, with four cross lines of the same piping as connections between the two parallel lines. This rectangular steam loop has dimensions of about 56 x 103 ft, but as the expansion even in the longer direction of the piping does not exceed ¼ in. no expansion joints have been used. Any boiler can be cut out or in at will, and each of the four cross connections has two valves, so that in case of need the pipe could be cut out at both ends. Along the side walls of the boiler room the steam mains are supported by cast-iron wall brackets, spaced an average distance of 8 ft. The smokestack is built up of steel plate, 150 ft. high and 9 ft. diameter at the top, and is self-supporting. It is mounted on a brick pier with granite coping, 24 ft. square and 19 ft. deep, and at the anchor bolts at the bottom the stack flares out to 17 ft., while it is lined with fire brick for 120 ft. up. Its cap carries a ring of incandescent lamps, which make a conspicuous beacon on special holiday occasions. The boilers are hand-fired with West Virginia bituminous coal, evaporating 10 pounds of water per pound, with steam at 120 pounds pressure, and water delivered to the economizer at 180° F. Coal storage to the extent of about 1,200 tons is provided in the basement of the new building. Feed water for the boilers is taken from two return tanks in the basement below the boiler room, the supply being furnished from the District supply, the condensers of the refrigerating system and from the heating returns. The steam for the feed pumps is taken from an auxiliary set of steam mains. There are eight Worthington feed pumps and eight Worthington circulating pumps, all set on glazed brick piers; the feed in the basement, and the circulating in pairs at the ends of the two rows of boilers, each pair cross connected for interchangeability. The exhaust from the feed and circulating pumps is utilized in two Baragwanath closed feed water heaters overhead in the boiler room. The fittings throughout the system referred to above were made specially of cast steel by the

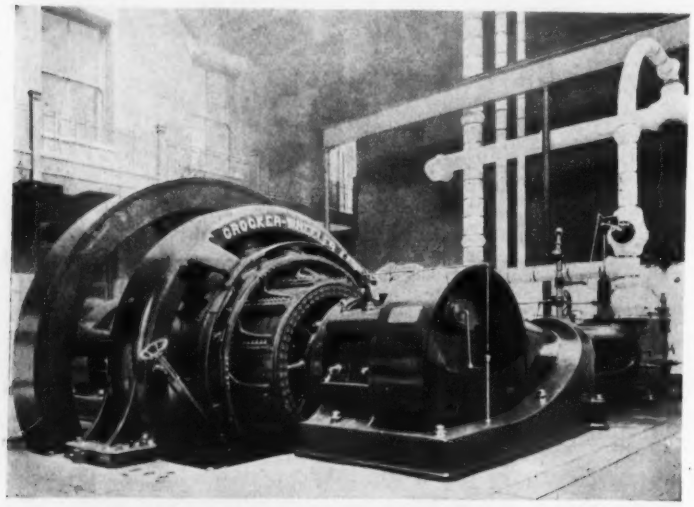


FIG. 10.—ONE OF THE GENERATING UNITS.

Bethlehem Steel Company, and the valves, like the rest of the steam plant, were designed by Mr. Collins.

Other pumps not noted above, but distributed around the power plant or adjacent in the basement, are all driven by electric motor. The vacuum pump for the steam heating system is operated through single-reduction gear by a 15-hp, 120-volt General Electric motor, and the plunger pump for elevating the discharge from the vacuum pump to a tank elevated 10 ft. above it is driven by a double-reduction 3-hp motor of the same make. The pump for supplying water to the spirojector condensers has a double-reduction 20-hp General Electric motor; and the two fire and house pumps, each of 1,000-gallons capacity per minute, with a pressure of 100-130 pounds at the pump, are driven by single-reduction 90-hp General Electric open multipolar motors, shown in one of the engravings. The cooled and filtered drinking water distributed all over the building to some 70 aluminum bronzed iron fountains recessed in the walls is furnished by means of a Knowles triplex pump driven by a 5-hp Crocker-Wheeler motor; and as indicative of the average North American thirst in summer it is interesting to note that the plant cools down daily not less than 4,000 gallons, or not less than a gallon to every parched employee in the Office. The time-honored, hard-worked "growler" of the printing office of one's youth is, indeed, remote and out of date.

THE SWITCHBOARD, ETC.

The main features of the boiler, engine and dynamo equipment having now been considered, it is time to speak of the other not less

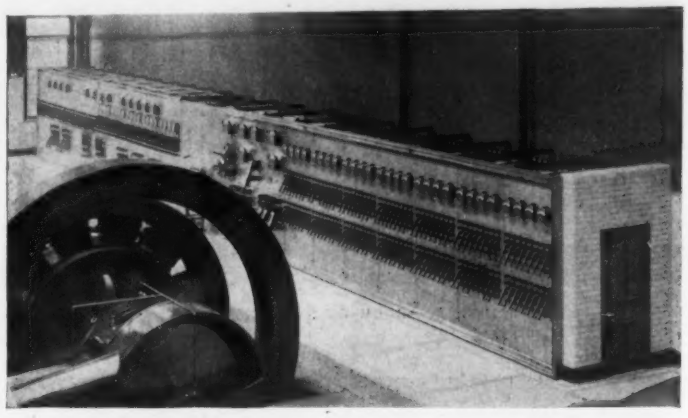


FIG. 11.—VIEW OF SWITCHBOARD FROM GALLERY.

important parts of the plant, such as the switchboard, which itself constitutes a striking element of the ensemble. It will have been gathered from what has been said that the Printing Office is one of the show places of Washington, and the power house is a part which visitors always take in. The handsome skylighted room is very light, not only because of the glass monitor roof, but on account of the interior lining of glazed white brick to a height of 9 ft., with red-faced brick above. The gallery floor and that of the engine room in front of the switchboard and around the side is of marble mosaic in figured panels; while within the brass railing around the generating units the floor is composed of cast-iron plates. The roof trusses and the traveling crane are painted in an agreeably cool shade of green, and the total effect of the room is excellent, the machinery and the switchboard being set off in artistic relief. The crane is an electric one of 25-tons capacity, built by Pawling & Harnischfeger, of Milwaukee, and supported by columns of 6-in. heavy wrought-iron pipe filled with concrete set about 14 ft. apart. The girders are braced to the structural framework of the building and these lateral braces support the steam header in the room.

The switchboard here shown is of a pinkish gray Tennessee marble, 82 ft. long and 9 ft. high, standing about 6 ft. from the wall and accessible from both ends. There are two sets of bus-bars, one for light and one for power, and this subdivision of service is maintained throughout the building, although the generator switches are double-throw, so that any generator can take care of either set. These switches are also double-pole, the equalizer switches being separate. A 5,000-amp. tie-in switch has also been provided of the circuit-breaker type without the automatic tripper, for connecting the two sets of busses together. There is likewise a large single-pole, single-throw switch for connecting together the light and power equalizer busses, in case two generators should be operating one on light and the other on power, with the tie-in switch closed. Each of the feeder switches are double-pole, double-throw, so that they can be independently thrown on either set of bus-bars. The board is virtually in two sections, the latest section for control of supply in the new building having been built by Albert & J. M. Anderson Manufacturing Company, of Boston, and consisting of nine panels, with a length of 34 ft—two generator panels and seven feeder. Here the feeder switches are in two rows. One set of busses extends along the middle of the panels in the rear of the board, with connections to feed both rows of switches, the upper ones when the switches are in the down position and the lower ones when the switches are in the up position. The other group of bus-bars is subdivided into two sets, one for the upper position of the upper row of switches and the other with less copper being

installed only as a safety or emergency provision for the lower position of the lower row. All the feeders are protected by I. T. E. circuit-breakers mounted on marble panels at the rear of the board, and the generators also are protected by I. T. E. circuit-breakers behind the board, which can be thrown by means of push buttons on the front of the board. These breakers were supplied by the Cutter Electrical & Manufacturing Company, of Philadelphia, whose contract called for two 5,000-amp., double-pole circuit-breakers, 28 double-pole, breakers of 300 amp., and 28 double-pole, 600-amp. breakers. The Anderson contract on the new board called for the two 5,000-amp., double-throw knife switches; two 5,000-amp., double-pole, single-throw knife switches; one 5,000-amp., single-pole, single-throw and 56 600-amp., double-pole, double-throw knife switches, all of which are of special design, hand-finished, while the clamping nuts, bus connections, etc., have ground contacts.

The new section alone of the board carries about 25,000 pounds of copper exclusive of the measuring instruments, which include two illuminated dial voltmeters 0-150 volt, one illuminated differential voltmeter, two illuminated ammeters 0-6000 amp., one illuminated ammeter, 0-5000 amp.; 20 round pattern ammeters, 0-500 amp., and eight round ammeters 0-750 amp. All these were made by the Weston Electrical Instrument Company, of Waverly, N. J., and are finished in copper and black. The leads of the two large generators are also brought out to two Thomson recording wattmeters furnished by the General Electric Company, each with a capacity of 5,000 amp. at 125 volts. A tell-tale panel of all wattmeters is placed also in the office of Chief Electrician Tapley, who has spacious quarters, with filing cases and other adjuncts, on one of the main floors near by. A daily log is carefully kept of current output, based on 15-minute readings, and checking up each branch of supply. Some idea of the work done can be formed from the fact that the recent daily load in December, when the new building had hardly got into shape, has been from 8,200 to 8,900 kw-hours daily, and that during November the total output was not less than 167,000 kw-hours.

The board itself is bound by handsome heavy copper moulding, with iron framework, and angle-iron braces, cable carriers, etc., all of which was given two coats of the best asphaltum paint. Every detail of the board has been most carefully planned out for safety and perfect finish. No electrolytic copper was allowed, all being pure Lake (Calumet & Hecla) rolled hard-drawn, or soft-drawn, according to the part. Bolts used in making the electrical connections are made from hard-drawn brass rod, with solid heads and all flanged nuts are of pure cast copper. All finish on the front of the board, of switches, brackets and connections, is "drawn file finish"; all surface contacts are made with ground joints, and all edges are champered 3/64 in. Standard requirements in every respect pushed to their limit have been deemed none too good for the board and its accessories, in view of the imperative necessity of maintaining service at all times under all contingencies.

Back of the board extends a rubber-covered walk and a ladder drops down to the engine room basement, where the system of distribution from the board may be said to begin. The conductors as they leave the board and enter the iron conduits against the outside wall of the power house being shown in one of the cuts herewith.

Lighting the Tuileries.

Reports from Paris state that the lighting of the Tuileries Garden is not yet an accomplished fact. There have been differences of opinion between the State, the owners of the property, and the authorities of Paris as to which of the powers should direct the works. The question is now decided in favor of the State, and though the city engineers are actually conducting the operation of laying down the wires, it is under the superintendence and direction of the French Government. A further difference arose over the design to be employed for the lighting standards. The model submitted to the State architect by the municipality was rejected as bearing the arms of the city, and M. Redon has now himself designed and had cast a very artistic candelabra, which will be adopted. The new lamps are of the style known as "Art Nouveau," and are far finer than those proposed by the city. They will bear comparison with the four beautiful standards which now adorn the four corners of the Place de la Concorde, or with those others, different but equally handsome, around the Opéra.

Testing Large Alternators.

BY W. E. BURNAND.

THE tests mainly required on alternators are for efficiency, regulation on unity and lower power factors, and for heating under load. Two methods appear to be available for making these tests; first, by the rather barbarous method of loading up the machine with resistances, choking coils, etc., or, second, by more scientific methods which may be said to have had their commencement with Hopkinson, in which the machine under test and other apparatus connected with it are supplied only with the amount of power lost in the system. Unfortunately, the second method as hitherto practiced seldom gives results strictly comparable with what will occur in actual use with the machine, and so though it may be said to be scientific, if by science is meant measurement, it is hardly so if by this is meant measurement of the thing you want to measure. The first method, however, is so cumbersome and expensive that in the case of really large alternators, it becomes quite

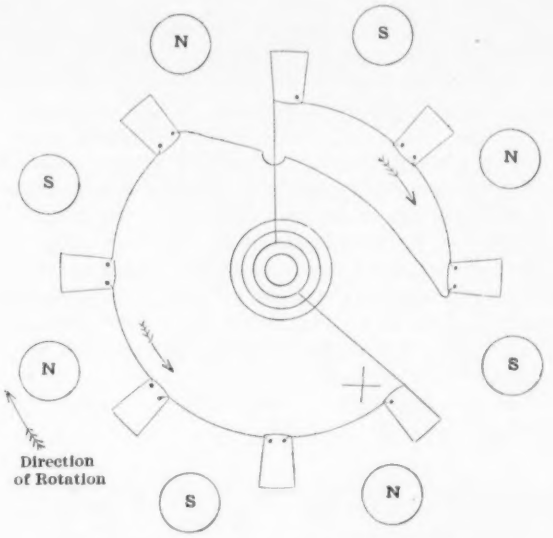


FIG. 1.—DIAGRAM OF COIL CONNECTIONS.

impractical, and the machine either has to go untested or some modification of the second class made, and the results that will occur in use with the machine deduced therefrom.

When two machines of equal capacity are available, they may be coupled together and the Hopkinson test pure and simple carried out, the power factor of the load being varied as desired by manipulation of the field strengths. As a rule, however, two machines are seldom available and recourse must then be had to opposing half (approx.) of the armature to the other half and circulating current through the windings in the manner described by Mordey, Behrend and others. But the methods that I have seen described have always been open to some great objection, such as, when the armature is the rotating part, putting great unbalanced strains on the machine, causing vibration which in some cases endangers the integrity of the machine, and also, in the majority of cases, the armature reaction and consequently the core losses and regulation observed are entirely unlike what will occur in actual use and, therefore, vitiates the results obtained as tests for regulation, efficiency or heating under full-load conditions. It seems to the writer that these objections can be overcome in a simple manner by the following methods:

First, as to the unbalanced strains in the machine, the cause of this will be readily understood by reference to the diagram, Fig. 1. Fig. 1 represents an eight-pole alternator, connected so that three coils oppose the other five. Connected thus, the five coils circulate a current round the armature against the e.m.f. of the three coils, the strength of which can be regulated by the field strength or by means of a rheostat in circuit. Thus half (approx.) of the armature will oppose the rotation of the machine, and the weaker half will help it, the difference in rotative effort plus friction having to be supplied from an external source. The arrows in Fig. 1 show the direction of this effort exerted by the two sides of the armature, from which it will be seen that both tend to force the armature in the same direction. If the armature is stationary, this is not usually

of any great consequence; but if the armature is rotating, the effect is just the same as if a heavy weight were located at the point marked *x*, which naturally tends to put severe strains on the framework of the machine. This could be balanced by a weight on the opposite side, whose value could be calculated from the apparent horse-power of the machine, the peripheral speed, diameter and power factor; but a much better way would be to prevent these strains altogether, by dividing the armature circuit into quarters instead of halves, as shown in Fig. 2, coupling *A* and *C* in series, opposed to *B* and *D*. By this means the stresses, which are indicated in the figure by arrows, balance themselves round the circumference of the armature, leaving no unbalanced strains to be transmitted through the shaft to the framework of the machine.

Having got over this difficulty, there still remains that of armature reaction. The difficulty here results almost entirely from the great lag or low power factor of the currents circulating round the armature, when the current is caused to circulate by a higher e.m.f. in one-half of the armature than in the other half. Thus, the current in the coils is nearly at its maximum when they are directly opposite the pole pieces of the machine, whilst with a power factor of unity the current is zero in this position, the conditions being reversed again in the midway position, i. e., the lagging currents are nearly zero here, whilst the power factor current should be at its maximum. It is evident that this must have a great effect on any test for regulation or efficiency. The power factor having comparatively little influence on the poles, whilst with currents lagging nearly 90° the coils on the weaker half have a powerful tendency to help the magnetic field, and on the stronger half a powerful demagnetizing tendency, thus giving rise to induced currents in the magnetic system, and also affecting the core losses of the machine. The mechanical strains also are not those met with in use; there is more tendency to vibration, and less of a straight pull or push backwards on the coils than is the case under load, when the current through the coils is at a maximum at the point midway between the poles; hence, in a position of maximum effect.

The effect this has with a current lagging about 90° is that for

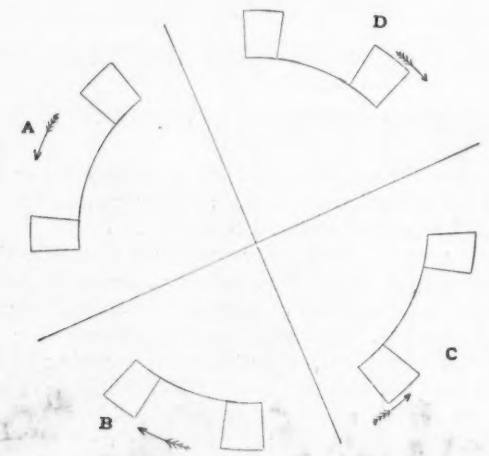


FIG. 2.—DIAGRAM OF ARMATURE CONNECTIONS.

every time a coil passes a pole-piece it is first subjected to a force in a backward direction till it gets opposite the pole and then in a forward direction till in the midway position. Thus there is a severe racking strain backwards and forward at the rate of four times the frequency of the machine, whereas with a current in phase with the e.m.f., the strain is always in one direction, either backward or forward considered with respect to the direction of rotation, according as the current circulates with or against the e.m.f.

The method devised by the writer to overcome these difficulties is to connect up the armature as in Fig. 2, the number of coils in the quarters *A* and *C* being equal to those in the other two quarters, *B* and *D*, so that the e.m.f of two quarters opposes and balances the e.m.f. of the other two quarters, and to circulate an alternating current through the armature from an external source of the same frequency as the machine under test, and whose phase with relation to this machine may be readily adjusted. This external source may consist of a small alternator with the same number of poles as the machine under test, and coupled to the same shaft; or it may be a machine of a different number of poles, driven from the shaft through chain or spur gearing. This machine, of course, may be in circuit with the large one, either direct or through a transformer, and need only be of a size capable of supplying the electrical losses in the large generator and connections. By this arrangement practically all the effects of full load can be simulated, in a manner to get practically reliable results. The auxiliary alternator can be so driven with relation to the machine under test as to circulate a current of leading, lagging or any desired power factor.

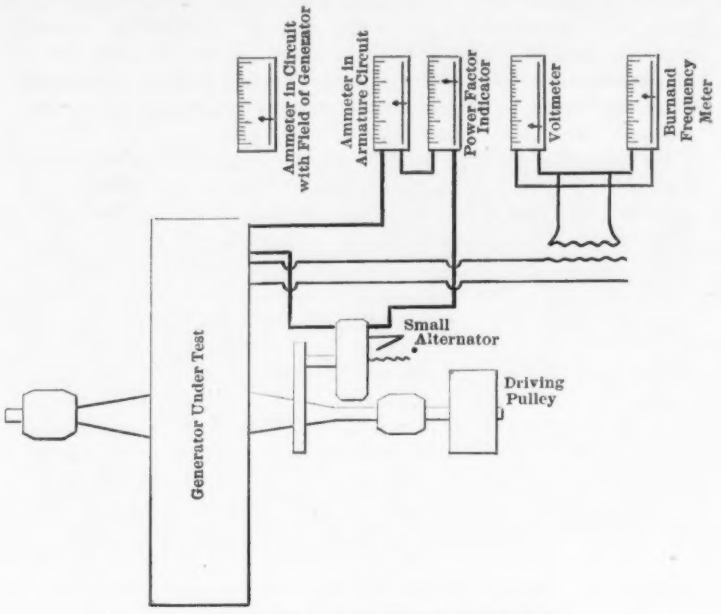


FIG. 3.—DIAGRAM OF TESTING APPARATUS.

The heating can, therefore, be determined for any of these conditions, and the regulation likewise. The efficiency can be determined from the balance of power required to drive the machine at its working speed with full load current circulating through the armature (at any desired power factor), after subtracting the power lost in the outside connections, the auxiliary alternator and the gearing driving it, all of which can be easily determined with an accuracy near enough to give materially correct results for the machine under test.

Fig. 3 shows the manner of testing the regulation of the machine, the voltmeter and power factor indicator being in connection with the half of the machine in which the current flows in the direction of the e.m.f.; the frequency meter being connected any convenient place, say in parallel with the voltmeter.

A reading is first taken with no current passing through the armature; afterwards a reading is taken with full-load current passing, the power factor of which can be regulated by causing the auxiliary alternator to lead, lag or keep in phase with the e.m.f. of the machine under test, the amperes being readily adjusted by a rheostat in the field of the small alternator.

Assuming the speed kept constant, the difference in the two voltmeter readings gives the drop in half the armature. If the machine is designed to work with the armature coils all in series, the regulation is, of course, double this value; if the two halves are to be in parallel the regulation is direct as given by the voltmeter readings. Should it not be possible to get the speed quite the same as when unloaded, the effect of this can be calculated from the difference in frequency—the e.m.f. being proportional to this at constant excitation.

A variation of this method might be to have a voltmeter on each half of the armature, the difference in the readings with full-load current passing giving the regulation; but the first method is probably preferable for a generator, as the armature reactions in the half referred to more nearly approach those of practice than is the case in the other half of the machine in which the current circulates against the e.m.f. as in a motor.

German Telegraphs.

Data to hand show that domestic telegraph business in Germany in 1902 was 43 per cent. above 1892, but it is said that business of Stock Exchange houses fell off 18 per cent. This may be due to the official restrictions on speculation.

Electrical Plant of the Lackawanna Steel Company.

THERE is now in process of completion, with part of the plant already in successful operation, a modern steel plant in which the electric current finds extensive application. The installation will serve to show the great strides being made in the use of electric current as an aid to the metallurgical engineer. Many of the applications are of especial interest to the latter because of the use of electrically-operated machinery where formerly the steam engine was almost exclusively employed. Other applications are of greater interest to the electrical engineer as having necessitated the solution of purely electrical problems. The plant further embodies features which are representative of the highest type of industrial engineering. It is true that all the advantages of an admirable site and ample capital are available. Nevertheless, the design embodies features which will conduce to the lowest operating cost consistent with a wise initial outlay.

The Lackawanna Steel Company was incorporated in 1902, with a capital of $40,000,000, to absorb the Lackawanna Iron & Steel Company and the Lackawanna Coal & Coke Company, the latter owning bituminous coal properties. The former operated a plant at Scranton, Pa., for the manufacture of steel rails, billets and merchant iron, and also several blast furnaces at various points. A site was purchased at Buffalo, N. Y., with a view to the removal of the Scranton plant to that point.

The output of the plant will consist of finished steel made by the Bessemer and open-hearth processes. As the produce of the plant is produced from raw material exclusively, the process will involve all the operations of coking, smelting, Bessemer and open-hearth steel making and the rolling of rails, billets, shapes and plates. The manufacture of the steel will further necessitate the storage and handling of very large quantities of ore, pig iron and coal, and the production, distribution and application of various systems of power and an auxiliary plant for the maintenance of the buildings, equipment and tools.

The tract of land acquired is about 3½ miles in length and nearly one-half mile in average width, on the south shore of Lake Erie, a short distance from Buffalo. The land adjoins the extremity of the United States breakwater, which affords a safe and commodious landing at the south end of the property. Here a ship canal 200 ft. wide, 21 ft. deep and 4,000 ft. long has been excavated parallel to the shore to afford entrance to ore-carrying vessels. On the opposite side of the property a railroad has been built to connect with the trunk and branch roads entering Buffalo.

The governing principle in the design of the plant has been the arrangement of the various buildings and equipment for the several processes in comparatively long and narrow areas parallel to each other and to the ship canal, such that the material in the various stages of manufacture is advanced progressively with the least expenditure of time and labor. To aid in this a system of longitudinal and belt tracks has been installed throughout the entire plant. Adjacent to the shore of the lake and extending to the ship canal is a complete coke plant, consisting of 940 by-product coke ovens with a capacity of 4,000 tons a day. To the south of this is a coal storage plant and yards for coal trains. Coal is received by rail and about 150,000 tons will be stored for emergency use in circular piles commanded by electrically-operated revolving locomotive cranes. Parallel to and approximately 75 ft. from the ship canal is located an ore dock which is about 270 ft. wide and ultimately will have a length of 2,500 ft. This consists virtually of a pocket about 13 ft. deep lined with concrete and supported on piles. The ore dock has a capacity of 750 tons of ore per linear foot, which will be piled on it to the height of about 70 ft. in the middle. The ore is unloaded from vessels and transferred to the former by five ore-unloading machines made by the Wellman-Seaver-Morgan Company, which travel from end to end of the ore dock, and are electrically-driven. Three ore-reloading machines of the same make, also electrically-operated, transfer the ore to steel bins set along the opposite side of the ore dock. Here the various grades of ore from different mines are deposited in separate steel bins.

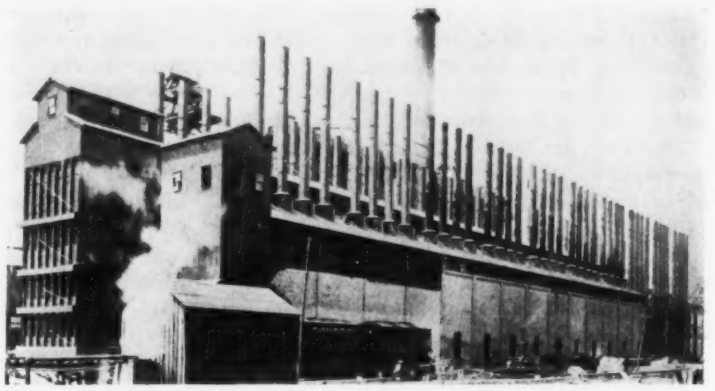


FIG. 2.—GENERAL VIEW OF BOILER HOUSE NO. 2.

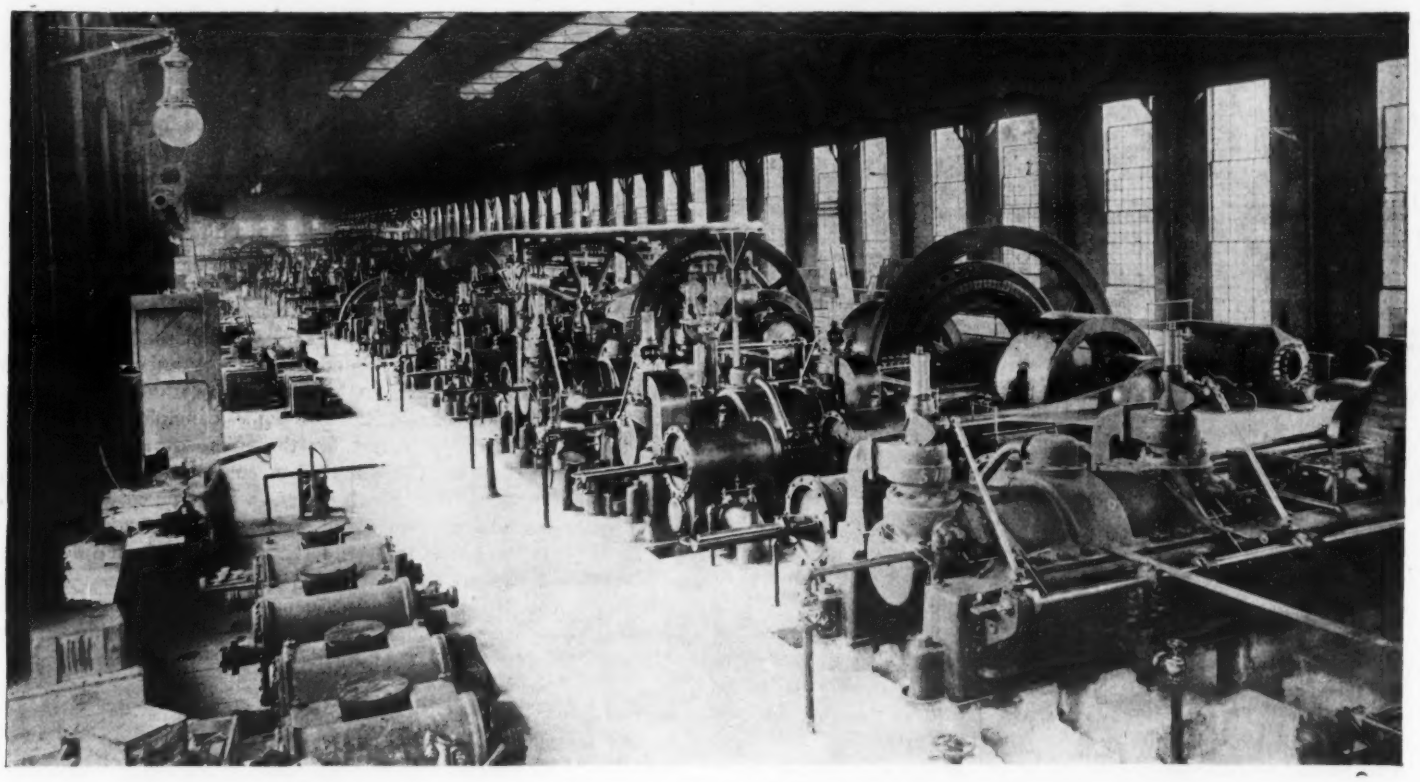


FIG. 1.—VIEW OF POWER HOUSE NO. 1.

After being discharged from these and weighed, the ore with the required amount of coke, limestone, etc., is then hauled by a cable up a steep incline and the contents of the car discharged by an Otis automatic electric machine into the top of the blast furnace. These furnaces extend in a row parallel to the ore dock and storage bins. At present two 300-ton furnaces are in operation, while four others of a capacity of 800 tons are in process of erection. The boiler and engine houses then follow, being arranged in a parallel group about 300 ft. wide and 3,000 ft. long. These separate the steel furnaces and rolling mills from the rest of the plant. Starting east from the lake shore in the various divisions enumerated, the materials are moved transversely in process of manufacture. The Bessemer works are in line with a mill for blooming and finishing heavy rail sections and one for making commercial billets, beyond which are two other rolling mills for light rails and for spliced bars and shapes. The most easterly division will contain the open-hearth furnaces, which are in line with three sets of heavy roughing mills delivering to other mills making finished plates and structural shapes. In these divisions the molten iron is received at the north end, and, passing continuously south without being interrupted or reversed, is carried in a long straight path through all the processes of manufacture. The finished steel is delivered for shipment or temporary storage at the southern extremity of the plant. In the northeast corner, adjacent to the steel furnaces, are located the foundry, machine shop and various auxiliary shops and buildings for the construction and maintenance of the plant.

The general scheme of power supply for such a large steel plant is one requiring a comprehensive treatment of the problems involved, which are not only of an engineering, but economical nature as well. As in the layout of the buildings and of the equipment, such methods and apparatus are adopted as will result in the lowest operating expense consistent with the least investment. The predominating principle, however, considered in the operation of the plant is that of certainty of operation, and the design consequently is affected to that extent. Economy is of minor importance, although receiving

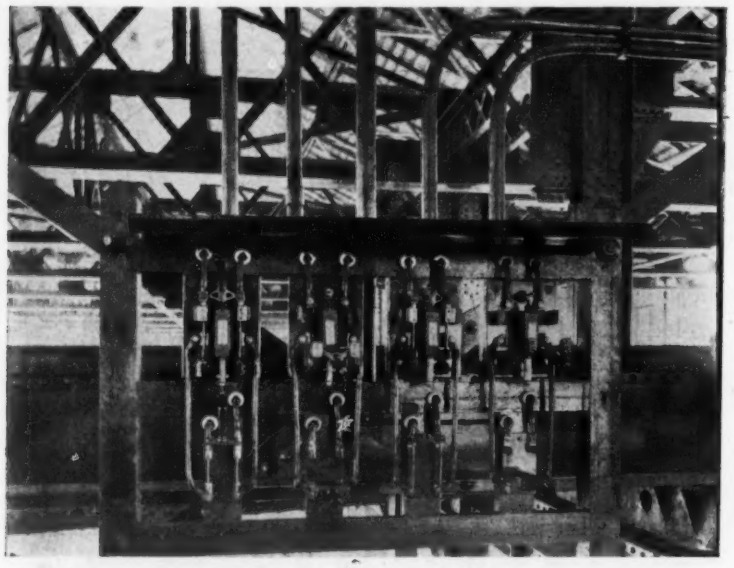


FIG. 3.—SWITCHBOARD FOR TRANSFER TABLE, BESSEMER HOUSE.

attention wherever possible. As a consequence, the utilization of by-products has affected the problem materially.

The installation is of unusual interest, as affording a means for the study of the various motive powers as applied in a steel plant which is being erected under the most favorable conditions at the present time. The steam engine will be used exclusively for the roughing and blooming mills, as rolling mill service has been held to be too severe for the electric motor. The gas engine, not being readily reversible, is not available for this class of work. The steam engines will be run condensing, a practice not heretofore adopted in this country, although triple-expansion condensing engines are in use in such service in Europe. Gas engines of 1,000 and 2,000 hp, utilizing blast furnace gas, are employed to drive the blower engines of the blast furnaces. Although engines of the same type, but smaller capacity, have been employed in similar service in Germany, this is the first instance of their use in this country. What would otherwise be a waste product is thus utilized to advantage and at a greater economy in the gas engine than if used in the boiler plant, and its energy finally made use of in the form of electric current for driving blower engines. The investment required for any given capacity is without doubt also materially reduced.

It will thus be seen that the steam and the gas engine are employed at all points which are vital to the carrying out of the various processes for the production of the finished steel. Furthermore, it will be found that the aggregate horse-power of these greatly exceeds that of the hydraulic, pneumatic and electric machinery employed. The electric drive, however, will be extensively employed for live operations, and more especially in that part not directly concerned in the production of the finished product, as in the coke and ore-handling and the auxiliary plant. The electric installation, furthermore, is of especial interest, as both direct and alternating current are used, the former for crane and variable-speed motors and the latter for constant-speed work. Hydraulic and pneumatic machinery is installed

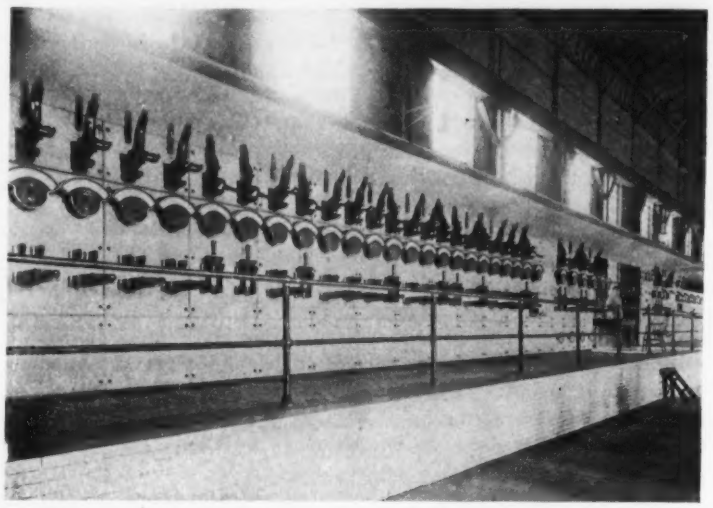


FIG. 4.—SWITCHBOARD IN POWER HOUSE NO. I.

under such conditions as are most favorable for its use or where absolutely necessary, as for instance, in the use of compressed air for the starting up of the gas engines.

As a consequence, one large central power house has not been erected. Each pair of blast furnaces is served by its own power plant operating the blower engines. Boiler houses are being erected at such points as will most economically supply steam to the steam engines located in the various mills. The main power house, which contains the electrical plant, as well as a pumping station which supplies the entire plant with water, receives steam from one boiler house which is located a short distance from both. Part of the boilers in the various boiler houses are fired with blast furnace gas. To insure against interruption of service and possible break-downs, the various boiler houses are interconnected by an equalizing steam main. This will also serve to take care of any sudden excessive demand at any point in the plant. This same principle is also pursued in regard to the supply of gas for the gas engines located in the various power houses. The plant when completed will also contain a producer gas plant from which the gas will be piped to the various gas engines for use in cases of emergency. As already stated, certainty of operation has been considered paramount in the design and operation of the plant.

Boiler house No. 2, which is the larger one of those at present constructed or contemplated, presents several interesting features. Although this contains Cahall vertical water tube boilers of a total capacity of 20,000 hp, a 250-hp size has been adopted, each boiler having its own independent stack, as will be seen in Fig. 2. Another feature which is of interest in the comparatively small coal storage capacity which has been provided, as coal is readily obtainable from the coal storage yards located near the coke plant. The capacity of the bins is merely such as to tide over any irregularities in unloading. Special precautions have been taken to prevent a shut-down. The main steam heater consists of a ring main with branches for power house No. 2 and the pumping station taken off at two points. Valves have been installed at various points such that one-quarter of the total number of boilers can be cut out at any time without in any way interrupting the service.

The boiler house is of the steel skeleton brick curtain wall type of

construction. It is 68½ x 460 ft. in size, and contains 80 Cahall vertical water tube boilers arranged in two rows facing each other in batteries of four each; 48 of these are equipped with Roney stokers, whereas 32 will be gas fired. As the surplus blast furnace gas will be utilized in this plant, the boilers are equipped with grates for hand firing. This will be resorted to whenever the supply or the quality of the gas is deficient. It is also necessary for starting up a boiler. The blast furnace gas is not purified, although pockets are provided in the supply pipes at the boilers for the deposit of any dust contained in the same. It may be mentioned here that this will be the only plant requiring coal as a fuel, as the others will be gas fired exclusively.

As the steam header is more than 500 ft. in length, it has been anchored at the center of each side of the boiler house. A double bend is provided in each line, connecting a battery with the main header to take care of expansion. A very long elbow is provided at each boiler, which, by closing two valves located between the header and the former, can be entirely removed to permit the removal of tubes. A monitor in two halves of a larger diameter than the boiler is bolted to the roof over each. This can be entirely removed for repairs of whatever nature, and also serves as a ventilator. All steam valves 12 in. long or larger are by-passed. Drips under operating conditions are exposed, and 8-in. cast-iron pipe is used for blow-offs in the ground leading to the sewers. Compressed air is used for blowing out and feed water for washing out boilers. The stacks are 28 in. in diameter and 75 ft. in height above the grates. A boiler pressure of 125 pounds is carried, but this is reduced to 80 for some of the old machinery.

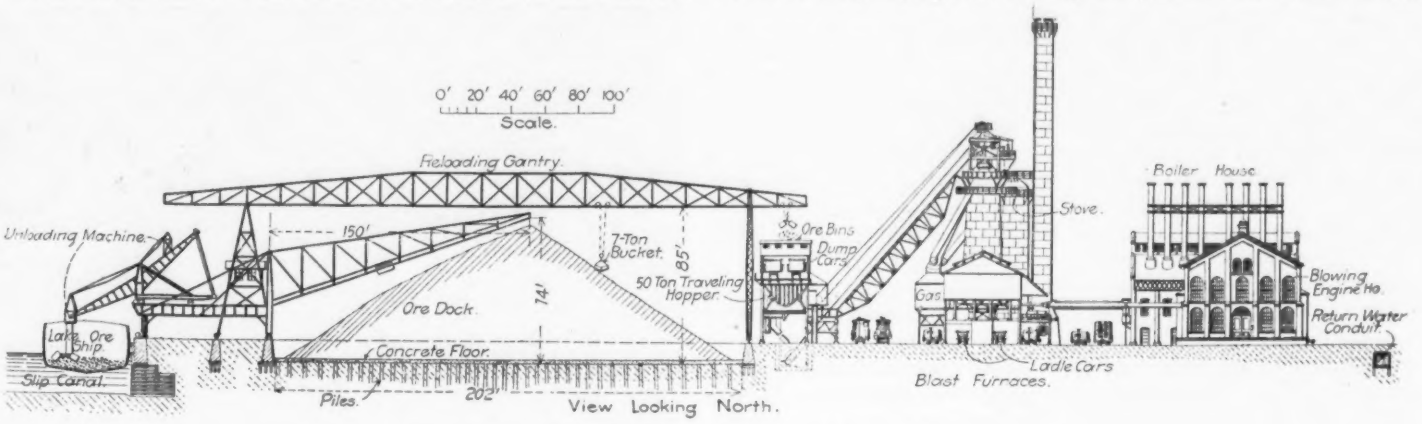


FIG. 5.—SECTION THROUGH ORE DOCK AND BLAST FURNACES.

The coal storage plant consists of a tower to the south of the boiler house. This contains two bins, one of the 200-tons capacity called the service bin, and a reserve bin of 300-tons capacity. The coal in the latter is available for use in the boiler house only on being discharged and re-elevated to the service bin. The coal is discharged from railroad cars and delivered by a scraper conveyor from the hopper underneath the track to the flight conveyor, which in turn elevates the coal to either bin. A traveling coal pocket equipped with two 7-ton coal bins, receives its coal from the service bin and conveys it to any required point. This is in the nature of a traveling crane, and its character can be readily understood from Fig. 10. The ashes are discharged in the basement into a pocket of a capacity of 28 cu. ft., which travels on an overhead trolley. From this the ashes are dumped into a skip, which elevates them to the ash bin, from which they are automatically discharged into cars as desired. All of the machinery is operated by direct-current motors. The coal-handling and ash-conveying systems were designed by Heyl and Patterson, of Pittsburg.

Boiler house No. 1 in its general features is similar to the one already described. This contains 16 Cahall boilers, which are provided with grates and gas fired. Coal is used whenever the blast furnace gas is of an inferior quality. Boiler house No. 3, which is south of the pumping station, is 65 x 184 ft. in size. This will contain 32 Cahall boilers gas fired, and will furnish steam to several engines in the Bessemer rail mill.

As already stated, each pair of blast furnaces will have its own power house, containing an equipment of gas engines for driving blower engines. By utilizing the blast furnace gas in gas engines a saving is obtained as compared with burning gas under boilers, which has hitherto been done exclusively. Only one-third to one-fourth the gas is required by this method as compared with the other, and a further saving is made possible by the omission of the boiler equipment with its attendant cost of operation. The gas engines are of the Körting type, and made by the De La Vergne Refrigerating Machine Company. The engines are operated in pairs, each one being one-half the capacity of the unit and are of the double-acting, two-cylinder type. They differ to a great extent from the gas engines made in this country. The gas used in the engines is taken from the top of each blast furnace through three Downcammer flues leading to a dust collector. After being purified in centrifugal washers operated by induction motors, and its temperature reduced to about 80° F., the gas is delivered to the mains at a pressure of about five ounces. Each engine is equipped with an electric speed governor. A Monarch engine speed limit switch is belted to the engine shaft. This switch, when the engine exceeds a given speed, closes a battery circuit in which a solenoid is connected. This sole-

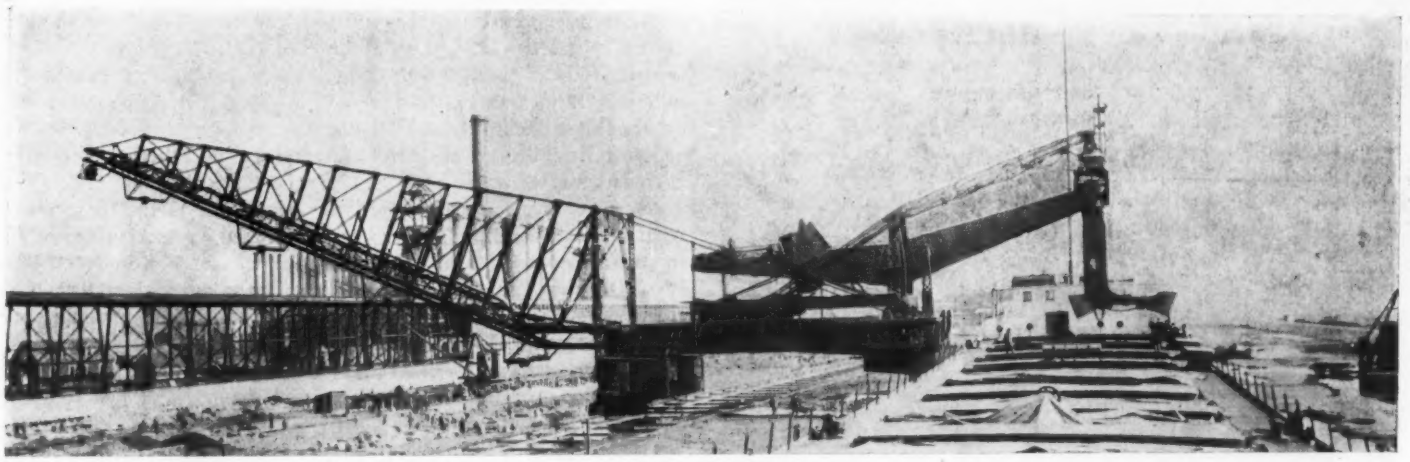


FIG. 6.—ELECTRIC ORE UNLOADER IN OPERATION.

noid operates a multi-point switch, which short-circuits magneto igniters of the engine, and consequently there are no more explosions in the engine cylinder until the speed falls to normal.

Blowing engine houses Nos. 2 and 3 will contain eight 200-hp engines each. As each pair of blast furnaces is operated as one unit, and as the utilization of the excess at any other point would involve an expensive pumping plant, besides introducing complications, it is self-evident that such a course is the most economical one to pursue. The blowers in blowing engine house No. 1 are operated by steam engines which were in use at the Scranton plant. Boiler house No. 1, which supplies the steam for these engines, has already been described. The use of the steam engine was resorted to in this instance because new machinery of the required type could not be obtained in time. The gas engine plant will probably displace the present one at some time in the future.

A pumping station which supplies water for the entire works has been built south of boiler house No. 2, from which it obtains its supply of steam. This contains at present two 50,000,000-gallon Wilson-Schneider direct-current, triple-expansion pumps. The pumping plant has its own Weiss counter-current condensing plant, built by the Southwark Foundry & Machine Company. The circulating and air pumps are operated by Porter-Allen engines. A 100,000-gallon water tank has been installed, from which 14 16-in. lines radiate. The water is obtained through a concrete tunnel from the lake.

Power house No. 2, the first to be built, was used during the early construction period, and is held in reserve at the present time. Power-house No. 1 is the most centrally-located and the most important. It contains the electrical plant, the air compressors, the hydraulic pumps and several blowing engines for the Bessemer plant; in fact, all of the power plant which it has not been considered advisable to install in separate power houses. It contains all machinery for the generation of power which is to be distributed in small units over the entire area of the works. The power house is 77 x 725 ft. in size, and of the same type as employed for all buildings, namely, steel skeleton with brick curtain wall construction. A 25-ton electric traveling crane built by the American Engineering Company commands the entire floor space. It is heated by the Buffalo Forge Company's hot blast system.

Compressed air for the various pneumatic tools used throughout

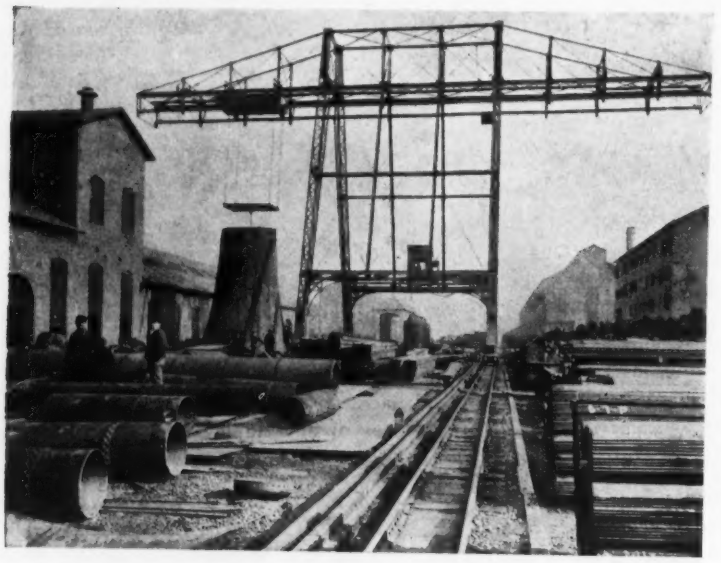


FIG. 7.—LARGE ELECTRIC GANTRY CRANE.

the works for operating the bells of the blast furnaces, for starting the gas engines and for many minor purposes, is supplied by four 14 x 16-in. Ingersoll-Sergeant cross-compound air compressors, each rated at 950 cu. ft. of free air per minute at 100 pounds pressure. Pneumatic machinery for tilting converters, manipulators, etc., is operated by water at a pressure of 450 pounds, three accumulators being installed in the building. There are two Snow and two Knowles 20 x 9 x 36-in. duplex pumps and seven 29 x 9½ x 36-in. Worthington pumps. The boiler feed pumps for power house No. 2 are also installed in the building. There are one Blake and three Knowles 30 x 16 x 24-in. pumps. The blowing engines housed in the power house supply air to the converters in the Bessemer steel department. There are four of these, two of these having engines 52 x 60 x 60 in., and two 50 x 54 x 60 in., made by the Allis-Chalmers Company. The engines are condensing. A 9,000-hp Weiss counter-current condenser has been installed. The exit pipe located in the basement is a built-up riveted wrought-iron pipe, which increases in size from 24 to 66 in. The circulating and air pumps are operated by Porter-Allen engines. The condensing water is supplied by the pumping station.

The electrical equipment of the power house presents several interesting features. The size of the generators has been limited to 500 kw, as gas engines of a larger size than 1,000 hp were not considered practicable at the time the plant was designed, although as already noted, engines of 2,000-hp capacity are being installed at present in the blowing engine houses for the blast furnaces. Another

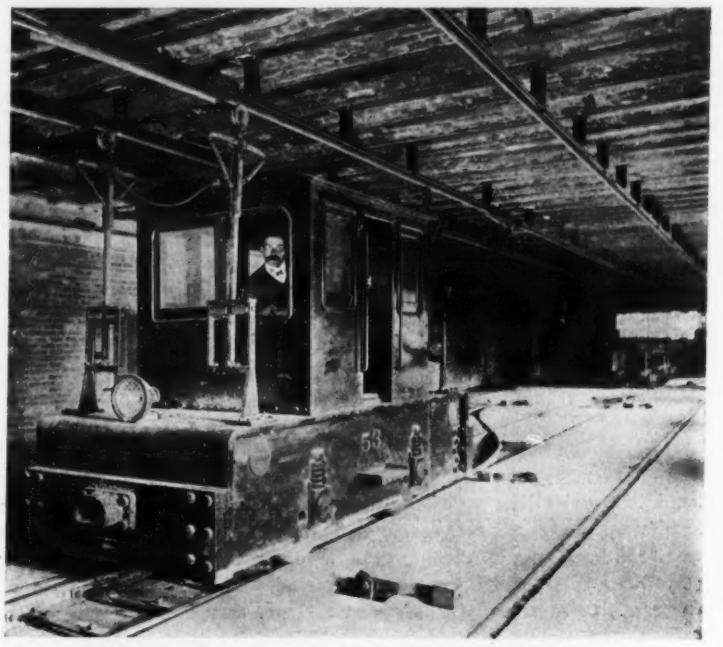


FIG. 8.—ELECTRIC LOCOMOTIVE, BESSEMER HOUSE.

feature is the use of both direct and alternating current in the plant. This course is more than justified when it is considered that large units were impracticable, and further that there are five direct and five alternating-current units of 500 kw each. Nine of these are driven by gas engines, whereas the other, a direct-current generator, is driven by a 36 x 48-in. Porter-Allen condensing engine. This unit is held in reserve for use in case the supply of gas is deficient or should fail entirely. The alternators are three-phase, 23-cycle, 440-volt machines of General Electric make, whereas the direct-current generators are 250-volt Sprague machines.

As gas engines are employed to operate the alternators, a somewhat unusual condition, these are guaranteed to operate successfully in parallel on condition that the maximum variation in speed of the revolving fields shall not exceed .2 of an angular degree on either side, of uniform speed, and to operate without cross currents should a means be adopted for mechanically coupling together when in place. There will be some thousand motors eventually, of a rated capacity of about 32,000 hp. The gas engines driving the generators are similar to the 2,000-hp units already described. These engines have cylinders 23¾ in. in diameter with a stroke of 43¼ in., being operated at 100 r.p.m. The generators are mounted on a crank shaft between the two engines. The cooling water for the cylinders is circulated by centrifugal pumps made by the Lawrence Machine Company, driven by Westinghouse induction motors. The engines are started with compressed air from the compressed air lines. There are three exciter sets, each consisting of a General Electric 125-volt, 37½-kw generator, direct-connected to a 10 x 10-in. Harrisburg Foundry & Machine Company's engine. There are also three 115-light, 6.6-amp. Brush series direct-current arc light machines, direct-connected to 1,000-hp General Electric induction motors.

The switchboard (Fig. 4) is simple in its design and substantial in its construction. It is built on a slightly raised platform, commanding a view of the electrical machinery. There are three sections, separated from each other, there being an alternating and direct current and a series arc board. The direct-current switchboard consists of five generators, one load and 14 feeder panels, the

latter containing two circuits each. Each circuit is equipped with one double-pole, double-throw switch, a 2,000-amp. ammeter and a circuit-breaker in one leg of the circuit only. The bus-bar copper has been figured on a basis of 800 amp. to the square inch at normal load. Although all circuits are protected by circuit-breakers, this is done nevertheless in such a manner that certainty of operation is assured, and at times a piece of apparatus may be sacrificed in maintaining an uninterrupted service. The alternating-current board contains five generators, one exciter, one load and 20 feeder panels, each of the latter containing two circuits. These are provided with instruments and switches, as in case of the direct-current circuits. Each circuit will eventually be equipped with an integrating meter. The alternating and direct-current switchboards were built by the Westinghouse Electric & Manufacturing Company, in accordance with the company's designs and specifications.

All feeders and mains are run in conduits, lead-covered paper-insulated cables being used. The conduit is built of tile in the usual manner, but on account of the mucky soil, special expedients have been adopted to maintain alignment. At intervals of 30 to 35 ft. a couple of piles are driven on 4-ft. centers, which are capped, and serve to support concrete steel cantilever arches, which in turn carry the current. In building the underground system, the ground is removed to the contour required, thus saving the expense of forms for the concrete arches. In the design of the distributing

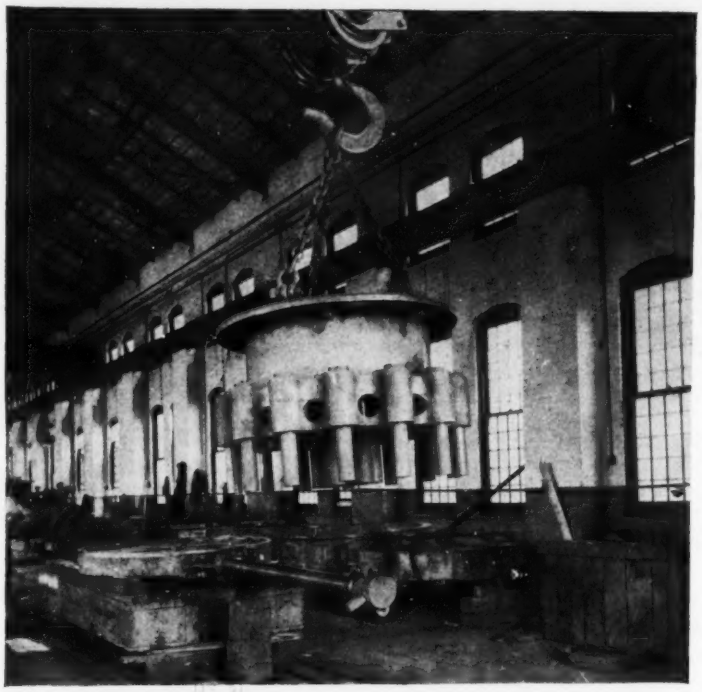


FIG. 9.—PIG IRON MAGNET.

system the limiting condition was not the drop in potential, but rather a five-watts loss per duct-foot in the underground system. All cables for direct-current circuits are 1,000,000 circ. mils single-conductor cables, made by the National Conduit & Cable Company. Those for alternating current are three-conductor No. 0000 cables of Standard Underground Cable Company's make.

The yards are lighted by series direct-current arc lamps, for which ornamental cast-iron posts have been erected at various points. The buildings and shops are lighted by constant-potential arc lamps and incandescent lamps. The former are placed two in series on a 220-volt, direct-current circuit. Current from the 440-volt alternating-current circuit is stepped down by means of transformers for incandescent lighting. As 25-cycle currents are employed, three lamps connected between the different phases are installed near each other, thereby obviating any disagreeable physiological effects.

The electric motor, as already stated, was considered not able to meet the severe and fluctuating demands of rolling mill service. The steam engines used for this purpose are of the reversing twin-cylinder type, geared about 1 to 2. To provide an elastic medium between the engine and the load, recourse has been had to a fly-wheel whose rim is driven by means of heavy springs from a spider keyed to the driving shaft of the mill engine, the spider and the inner shaft of the fly-wheel having a number of corresponding toothed projections. Then engines are operated by the throttle entirely, although equipped with link motion. The maximum at times will reach 6,000 to 8,000 hp, and because of the number of passes the load will fluctuate from nothing to a maximum from 30 to 40 times in one minute. A continuous-indicator diagram may be likened to an alternating-current diagram, the amplitude being largest at the beginning and then increasing as the number of passages increases, this cycle of operations being repeated several times in a minute. The engines in this case will be condensing, a course not hitherto pursued in this country, although triple-expansion condensing engines are in use in such service in Europe. Each rail mill will be equipped with its independent Weiss counter-current condensing plant.

The use of hydraulic and pneumatic machinery throughout the works is practically limited to such conditions as are most favorable to use of either as against electrical machinery, although the division line is not always clearly drawn, depending to a great extent upon the variability, accessibility, etc., of either. Compressed air is used for various pneumatic tools in the shops, for operating the bells of the blast furnaces, for starting the gas engines, and similar purposes. Hydraulic machinery is used for tilting converters, furnaces and mixers, for operating car pushers, hoists and transfers in the rolling mills, and in such places where a large amount of power is to be exerted with certainty within the range of a piston stroke. Although the use of the hydraulic motor is confined to the operation of cranes, hoists, shop tools and auxiliary machinery in the various processes, it nevertheless occupies no insignificant position in the operation of the works. As already stated, the application of the electric motor in many instances is of unusual interest to the metallurgical engineer, although not in itself having necessitated the solution of any new electrical problem. In many other instances electrical methods have been introduced in the various processes. In other cases original electrical problems of unusual interest to the electrical engineer have been solved. The alternating-current motor is used only for continuous service, where ordinarily a shunt-wound, direct-current motor would have been installed. The use of the alternating-current motor in such cases possesses inherent advantages, as the absence of a commutator, its dust-proof character, etc., are too well known to require extended comment. The direct-current motor of the series, compound and shunt-wound type is used for all cranes and intermittent service necessitating frequent reversals.

The application of the electric motor to the driving of roller tables in the various mills has also required the solution of a difficult problem, which has been done in a most satisfactory and simple manner. The conditions in this case are similar to those met with in the operation of the engines driving the various mills, which has been described.

Another problem, which was successfully solved by Mr. E. D. Edmonston, the electrical superintendent, was the design of an electromagnet, which would successfully handle pig iron as thrown promiscuously in piles. Such conditions, of course, are not conducive to the handling of material on as economical a basis as in the case of plates and similar material. The electromagnet shown in Fig. 9 weighs 3½ tons and has a lifting power of 1½ tons. The features of the design are the use of adjustable poles which allow the picking up of the iron in any position. These are bi-polar and separated some distance, so that the flux will penetrate the pole to a great depth. To separate the poles such a distance in an electromagnet of such a size requires very large and deep windings, for which it is necessary to provide special facilities for ventilating, which is accomplished by inserting fibre rods. Being used under all sorts of conditions, the magnet has been designed in such a manner as to be protected in all kinds of weather, and to permit of ready repair. It furthermore combines mechanical strength with excellent electrical features, to withstand the rough handling to which it necessarily will be subjected.

The installation of electric traveling gantry cranes in the yards required the placing of the conductor at such a point as not to interfere with the conveying of material in any position to any point in the yard. On account of railroad tracks which cross those of the gantries, a continuous conductor, furthermore, was not feasible, as an exposed third rail could not be adopted, on account of the danger of shocks to the workmen and the possibility of a ground or short-circuit through the throwing of material across the tracks. The system finally adopted comprises a bare (Fig. 8) trolley wire

stretched between strain insulators placed in a trough formed by two hardwood pieces insulated from the ground. All crossings are bridged by a cable carried in a conduit. In this way it is not possible to make a ground, the trolley wire being placed below the level of the top of the wooden strips, and surface leakage is entirely prevented. The cost of construction is small, and repairs can be readily made. As the two collectors placed on the gantries bridge any opening, excessive sparking is prevented by the collector leaving one section.

Certainty of operation being the most important consideration, and the service required being of the most severe character, special precautions have been taken to prevent interruption of the latter. This is well shown in the case of a system of electric locomotives for haulage which has been installed in the Bessemer plant. There are three Baldwin-Westinghouse locomotives, each equipped with two 35-hp motors, railway rating. The controllers, four in number, are of a very flexible nature, permitting of their movement both in a horizontal and in a vertical plane to allow of the locomotives taking curves readily, as very sharp corners are made. A very substantial trolley construction has been adopted. This consists of a 2½ x 2¾ x ⅜-in. T-iron, insulated from the ceiling I-beams by vulcanized asbestos plates and washers. The trolley wire proper consists of a sheet of copper 18 x 2⅛ in., riveted to the iron. The solid construction adopted throughout is further illustrated at the switchboard, Fig. 3, one of several installed in the Bessemer house,

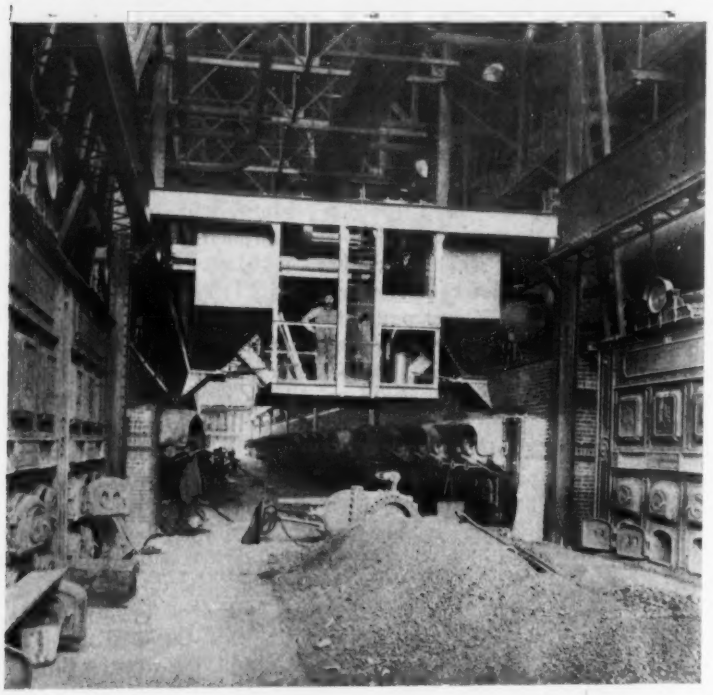


FIG. 10.—COAL-DISTRIBUTING CRANE, BOILER HOUSE NO. 2.

and which controls several transfer tables operated by series direct-current motors. All wiring is run in Sprague conduit, for which special fittings are employed.

Several interesting applications of electrical methods are in use about the plant. One of these is a mixer valve regulator for controlling the temperature of the hot blast on the blast furnaces. This apparatus consists of a regulating pyrometer with an extended pencil room, on which a fibre cup filled with mercury is fastened, a relay, a magnet and a globe air valve. As the pencil room of the pyrometer moves up and down it makes and breaks a battery circuit at the mercury cup. In this battery circuit is connected the relay which opens and closes a power circuit in which a large magnet is connected. This magnet controls a compressed air valve, and this compressed air valve in turn controls a large mixer valve.

Another application is that of an electric burner for blast furnaces. In the case of "freezing" of tuyeres, cinder notch or iron notch, the obstruction is removed by means of an electric burner. Formerly an oil burner or kerosene blow pipe was used for this purpose. The electric burner equipment consists merely of a brass clamp holding a 2-in. x 72-in. round carbon. A long wooden handle is fitted into this clamp, in order to apply the burner when in operation. A cable is tapped into this clamp, carried through a water rheostat and connected to one side of the direct-current power circuit. The other side of the circuit is grounded to the iron framework of the furnaces when it is necessary to use the burner. A current of from 500 to 1,000 amp. at about 80 volts at the arc is required to remove the obstacles.

The ore-unloading machines already mentioned and shown in Fig. — are electrically operated. In these the walking beam truck, walking beam and movements of a ten-ton bucket are controlled from the inside of the leg of the walking beam by means of small operating controllers connected with Electric Controller & Supply Company's magnetic switch controllers, which are placed adjacent to the motors for this work. It is thus possible to control the movements of the unloader without carrying the heavy power cables down into the leg of the walking beam, where the operator is stationed, and it is thus necessary to run only small flexible wires between the magnetic switch controllers and the smaller operating controllers.

It is impossible in an article of this scope to describe fully the various applications to which the erection of such a modern steel plant gives birth. This is further rendered impossible by the fact that a large part of the plant is still in course of construction, and increased confidence and the experience gained at present may lead to the further use of the electric motor and electrical appliances.

Mr. Henry Wehrum is general manager in charge of the Buffalo plant, and of the other properties of the Lackawanna Steel Company. Mr. F. du P. Thompson is the chief engineer of the company, who, believing that organization is essential to success, has gathered about him a most efficient corps of engineers. It has thus been possible to successfully carry into execution even to the minutest detail the general policies which have been outlined in regard to the construction and the operation of the extensive works. The mechanical engineering department is divided into four divisions—the engineering, the construction, the repairing and construction of shops, and the power and operating division, which is in charge of a mechanical and an electrical superintendent of power. The engineering division, under Mr. A. G. Hamilton, the assistant engineer, designs all of the various plants, buildings and equipment required. Under the former are nine division engineers, each one of whom has his own force of draughtsmen and inspectors, who inspect all work under construction designed by their respective departments.

Commercial Long Distance Telephony.

In discussing the commercial aspects of long-distance telephony, the *Wall Street Journal* remarks: "The consolidation of the 4,000 independent telephone companies in the Middle West, and a connecting up of the toll line system, will be the first real competition that the Bell Company has had in the long-distance service, although the independents have done a large short service business within their respective territories. The weakness of the various independent systems has been in the fact that they had no connection with the hub of the West, Chicago. This established, their position will be greatly strengthened. An authority on telephony says that the profit on long-distance service, excluding that between New York and Boston, is meagre for a distance in excess of 150 miles, and that on account of the extraordinary quality of construction and high standard of maintenance necessary, and regardless of rate the New York-Chicago lines cannot handle a sufficient amount of telephone business to make any profit. It must be remembered that it takes the exclusive use of two heavy copper wires to talk from New York to Chicago, and while a five-minute conversation is going on (to say nothing of loss of time in getting the subscribers together) the telegraph companies with their "quads" and a much lighter wire can transmit in five minutes 40 telegrams, at 50 cents, amounting to $20, as against $9 for a telephone call. Then the cost of maintaining of the lighter telegraph service along side of the railroads is from 25 per cent. to 50 per cent. less than the long-distance wires over the highways.

"Another important fact is that telegraph wires are not transposed, as are telephone wires about every 15 poles. This transposition is very expensive and increases cost of maintenance, as splices and tying to insulation is more frequent. The transpositions in a line of 30 or more wires is enormous, for the position of the wires upon the insulators the entire distance from New York to Chicago is changed about every 15 poles, and if another circuit is added, more transpositions are necessary. Successful service upon highway lines necessitates constant patrol at large expense."

Protection of Electrical Apparatus From Lightning and Other Destructive High Potentials.

By HOWARD R. SARGENT.

ELECTRICAL apparatus installed on lighting, railway, power and high-potential transmission circuits is subjected to abnormally high potential strains through various causes, such as lightning, switching, cables, governor troubles, differences in elevation between different portions of the circuits, etc.

Lightning is, in all probability, the worst of these conditions to be taken care of, and up to the present time we have not heard of any form of arrester which will entirely take care of a direct stroke. When a lightning discharge strikes any part of a circuit, the portion struck is generally damaged to a considerable extent at the point where the stroke takes place, and in a great many cases, if the stroke is near the station, the insulation of the apparatus in the station suffers in addition to the local trouble. We have seen numerous cases where, with the best possible protection, poles have been splintered, lines broken and short-circuits started, which have done considerable damage to all kinds of apparatus.

It is possible to take care of high potentials which are induced on lines through discharges from cloud to cloud, discharges from clouds to earth in the vicinity of the lines, or high potentials which have been merely induced by the presence of thunder storms. It has been observed that these induced charges in circuits may produce high potentials not only between lines and the ground, but between line and line in the same circuit, and it is, therefore, advisable to make arrangements to equalize these high potentials not only from line to ground, but from phase to phase.

Some districts are much more open to atmospheric disturbances than others, and it is often necessary to take greater precautions in some localities than in others, due to this reason. In the Southern States about 70 thunder storm days per year are experienced, while throughout the entire country there is an average of approximately 30 such days per year. Some of the installations in the mountainous States in the West have suffered to a considerable extent through the numerous atmospheric disturbances which occur in that district.

On high-potential circuits of considerable capacity, an arc produced by switching, circuit-breakers, fuses or short-circuits, causes an electrical oscillation of extremely high value. Voltages of more than double normal potential are often produced when connecting a circuit of considerable capacity to the generating system at no load. These high potentials subject the apparatus momentarily to enormous strains, and it is well to have some low break-down path in which the dynamic arc will be immediately ruptured, so that these high potentials will equalize themselves from line to line without damage to the apparatus.

In laying out circuits, it is frequently necessary and desirable to dip underground when passing through cities, or under rivers, etc., and in these cases some form of metal-covered cable is generally used. It has been noticed from numerous installations that high potentials invariably occur where these underground cables are used, due to resonance effects and these high potentials are often of sufficient value to break down the cables themselves, or the insulation of apparatus installed on the lines. The strains very often produce pinhole punctures in the insulation of underground cables and thus relieve themselves temporarily; they may, therefore, remain unnoticed for a number of months until the insulation becomes very much impaired, ultimately resulting in a complete break-down.

Whenever lines contain both inductance and capacity in noticeable quantities, high voltages which endanger the insulation of the whole system, and which it is impossible to detect on ordinary switchboard instruments, may exist. We, therefore, frequently find such abnormal voltages in circuits containing a combination of underground and overhead circuits, and in long-distance transmission lines.

A great many cases have been noted where engines and water wheels have raced, caused by the governors becoming inoperative and high potentials have resulted, which have caused serious breakdowns in insulation. This has generally occurred when a considerable load has been switched off from a circuit.

Particular mention was made at the recent general meeting of the A. I. E. E. at Niagara Falls of the abnormal high-potential strains which have been noted on long transmission lines running through mountainous country where considerable differences of elevation occur between different portions of the circuits. These differences in potentials, are, without a doubt, due to difference in magnitude of the atmospheric electrical potential at different altitudes, and in some cases the condenser effects of the line produce potentials considerably in excess of the line voltages.

In laying out protection against the troubles enumerated above, it is necessary to provide discharge paths from phase to phase and discharge paths from lines to ground with suitable ground connections, except when the circuits are entirely underground, when the ground connections may be omitted. In view of the fact that it is necessary to take care of considerable quantities of current from line to earth when lightning discharges take place, it is advisable to have an arrester of as large current-carrying capacity as possible, and with this in view it is often advisable to install a number of arresters in multiple where the conditions are particularly severe. With regard to potentials between phases, which are more of a static nature, these can generally be equalized with small flow of current.

In discharging a line to ground, the simplest form of discharger would be one single gap, or a series of small gaps with a break-down point just above the voltage of the circuit. Although it has been found that a single gap will discharge a line effectively, the single gap, of course, will not rupture the dynamic arc when it is once started by a high-potential discharge.

With a number of short gaps, it has been found that if a sufficient quantity is used, under certain conditions, the dynamic current is ruptured by chilling the arc down between the numerous cylinders; also due to the fact that in some of the gaps the value of the alternating wave is zero, and, therefore, after a high-potential discharge has passed, the dynamic arc does not start again. This arrangement of a large number of small gaps in series is, however, out of the question as far as practical use is concerned, as enormously high break-down voltage is necessary to overcome the gaps, resulting in injurious strains on the insulation of the apparatus. Under certain conditions of inductance, capacity, etc., a discharger of this construction will not interrupt the dynamic arc.

With a fixed length of spark-gap, a certain number of gaps are necessary before break-down will occur at a predetermined point above the voltage of the line, and this number of gaps has the power of interrupting a dynamic arc formed by a limited current value at the line potential. With this in view, it is necessary to place a determinate resistance in series with the gaps, in order to limit the current to this point. An arrester constructed in this way with non-inductive resistance is the simplest arrangement which can be made, and affords the best protection which, up to the present time, it has been possible to devise.

High potentials between lines or phases occur much more frequently than in the case with lightning, and it is advisable to increase the non-inductive resistance in series with the gaps to considerable extent, as this renders less liable the possibility of short-circuits, and as stated above, these high potentials between phases can be equalized through high resistances as well as through low resistances. A further reason for placing a considerable amount of resistance in series with the gaps when placed between lines is that in case of discharge from phase to phase, if the resistances are low, the circuit-breakers or other automatic devices on the line open, causing temporary shutdown, and this, of course, is inadvisable as well as annoying.

It is advisable to have all of the spark-gaps, resistances and operating parts of high-potential alternating-current arresters entirely in view of the operator, as this enables him to make immediately any changes or repairs which may become necessary during operating hours, and with this in view, it is always advisable to install switches in the lightning arrester circuits so that the lightning arresters may be isolated in case immediate repairs become necessary.

Although considerable doubt has existed as to the advisability of installing reactive coils in connection with lightning dischargers, it is believed by many prominent engineers that reactive coils are of considerable value in connection with the proper protection of apparatus. Without a doubt, the frequency of lightning disturbances varies greatly in different cases, although, as a whole, it is probably high. Inasmuch as the action of the reactive coils is not dependent on the voltage or frequency of the line, it is inadvisable to design a large number of coils having different reactances, and it is evident that a coil can be designed with ample current-carrying capacity, which may be used on a number of voltages, provided it has sufficient insulation for the highest voltage determined upon. In this connection air insulation is preferable between turns and layers, as other forms, due to minute discharges, gradually deteriorate and change, becoming partial conductors.

Protective wires have been used in a great many cases by different transmission companies with varying success, although the experience gained, as a whole, has been in favor of this form of protection. A great many of the troubles encountered through the use of this wire have been due to the selection of improper materials in making the installation. Barbed wire has been used in a great many cases, but the commercial barbed wire purchased on the open market is of very poor quality and has a tendency to hold water in the joints and interstices.

In Kalamazoo, Mich., different forms of protective wire have been used, placed in various relative positions with regard to the circuit wires, and it has been found that plain iron wire installed directly below the transmission wires furnishes practically as good protection as barbed wire installed over the transmission.

As a matter of fact, there are few reasons why this should not be the case, provided the iron wire is properly grounded at every third or fourth pole, as the disturbances which this form of protection is supposed to take care of are generally at considerable distance from the transmission wires. While this form of protection may help out in the case of a direct stroke of lightning, it is not to be presumed that it will prove entirely efficient under this condition of affairs.

While the experience of the above-mentioned company has been that a wire placed below the transmission is as satisfactory as if placed in any other position, it is as well to string it above the transmission lines at an angle of approximately 45° to the outside transmission wires, as without a doubt, this locality will aid in taking care of direct strokes of lightning.

With the improved lightning protective devices on the market, the grounded protective wire need only be resorted to where the most severe conditions exist, and then it should be put up in the most thorough manner with regard to the size and quality of the material used and with regard to grounds.

For direct-current work the general principles of construction mentioned above hold good, but in view of the fact that it is much more difficult to rupture a direct-current arc than an alternating-current arc, some other means are necessary of breaking the arc after a discharge has taken place.

Arresters with moving parts have been made for this purpose, but it will readily be appreciated that an arrester with moving parts is more of a menace than a protection, as many lightning discharges are immediately repeated over approximately the same course, and in this case the moving element is in the wrong position to take the second discharge, in which case the apparatus suffers. In addition to this, it has been found that the enormously high potentials, due to lightning, cause arcing and disintegration, so that the moving elements refuse to assume their normal positions of rest after a number of discharges.

After exhaustive tests in the laboratory and under practical operation the magnetic blow-out has been found to give most excellent satisfaction under all conditions, and the most satisfactory form of direct-current arrester is one consisting of a single spark-gap with sufficient resistance in series to shunt a portion of the dynamic current around the coil, so as to cause a strong magnetic field about the gap. The lightning discharge passes directly through the resistance and the spark-gap to the ground and the strong field immediately blows out the dynamic arc which follows, thus preventing damage to the arrester and to the apparatus.

In the installation of lightning arresters it is very undesirable to endeavor to effect a saving by cutting down the expenses connected with making proper ground connections, as fully 75 per cent. of lightning arrester troubles can be traced directly to this source. The connections from the line to the arrester and from the arrester to the ground should be as free from angles and bends as possible, and where turns are absolutely necessary the wire should never be bent at an angle, but in a curve of long radius; care should be taken that no inductive loops are formed by the complete arrester and its connections.

When the use of an iron pipe at the foot of a pole is considered advisable for the protection of the ground wire, a plug should be put in the top of the iron pipe and the wire soldered to it; otherwise the reactance of the ground wire surrounded by the iron pipe will impede the discharge.

Copper should be used for the ground, thick enough to prevent wasting away and having at least four square feet surface. The ground wire, which should not be less than ⅜ in. diameter in cross section and preferably in flexible strip form, must be carefully soldered and riveted to this plate, the joint covered with asphaltum, and the plate then buried in powdered coke in soil which is always damp.

Dry, sandy soil should be kept wet by artificial means if this is the only soil available for the ground connection, and it is advisable to dip several trenches radiating out 50 ft. from the main ground wire, in which ground wires are buried so as to get a large surface for the dissipation of the discharges. Where plates are buried in streams of running water or dead water, they should be buried in the mud along the bank in preference to merely laying them in the streams; and streams with rocky bottoms are to be avoided unless as a last resort. Where there are metal flumes, pipes or rails, it is advisable to rivet and solder the ground wires to them in addition to the connections to the copper plates, and when rails are utilized they should be thoroughly grounded.

In view of the fact that it is advisable occasionally to examine the underground connections to see that they are in proper condition, it seems advisable when the ground plates are installed to lay out exact plans of the locations of the plates, ground wires and joints, with slight descriptions of the same, so that at any future time the data may be referred to.

Revived Electrical Prosperity in Germany.

In the course of a report on returning trade prosperity in Germany, U. S. Consul-General Mason Says: "At length, after two years of anxious waiting and hoping, the crises in German industrial values which began in the spring of 1901 is definitely past, and a general recovery has not only begun, but has progressed so far as to have all the outward indications of permanence. To what extent the values of the prosperous period which preceded the collapse have been regained will be illustrated by the following table, which shows the market values of certain standard German industrial stocks on the 17th of April, 1900, when the general prosperity was at its height; on the 26th of September, 1901, when the depth of depression had been reached; on the last day of 1902, when recovery had definitely begun; and on the 20th of the present month, when the effects of returning activity had become manifest in the values of industrial securities. The exhibit includes electrical manufacturers, iron and steel works, iron ore and coal mines, and the Great Berlin Street Railway Company.

Company.	April 17, 1900.	Sept. 26, 1901.	Dec. 31, 1902.	Nov. 20, 1903.
General Electric Company	253.90	169.50	180.75	220.00
Siemens & Halske	176.00	145.00	120.10	140.00
Schuckert Electric Company	216.40	100.00	79.50	112.50
Electrical Enterprise Company	150.25	91.30	84.60	105.00
Electric Light and Power Company ..	114.25	96.75	93.75	109.75
Great Berlin Street Railway Company.	232.75	194.10	200.50	204.75

These companies may be taken as representative of the electrical industries of Germany. The foregoing comparison shows that while not one of them has recovered—in respect to the open-market value of its shares—the high-pitched prosperity of the early months of 1900, all have recovered in an important degree from the depressed prices of September, 1901, and each one now rules from 10 to 50 points higher than it did at the close of 1902.

An important element has been the fact that several of the leading electrical manufacturing companies—which have recently combined to avoid competition—have secured some important contracts for lighting and power plants, street railway installations, etc., in foreign countries, notably Mexico and South America. At a recent meeting of representatives from all the electrical manufacturing companies, it was found that they were, almost without exception, running on full time and with orders booked that will keep them occupied for several months to come. Many of these orders have been taken at what would seem in America low prices, but the German electrical industry is enormously developed, is equipped with up-to-date machinery, has an abundant supply of cheap, docile, skilled labor, and can turn out electrical machinery, cables, and all that class of work at minimum cost.

The Arnold Electro-Pneumatic Railway System as Employed on the Lansing, St. Johns and St. Louis Railway.

BY B. J. ARNOLD.

AS many of your readers know, I have persistently advocated the use of the alternating current directly in the motors for electric railways for several years (see *Transactions* American Institute of Electrical Engineers' joint meeting with the British Institution of Electrical Engineers, Paris, August 16, 1900; Niagara Falls Convention, August 24, 1901; Great Barrington, Mass., June 19, 1902, and New York, September 26, 1902). By referring to the discussions which took place at these meetings and to the technical papers, it will be found that there were few, if any other advocates, in this country of the alternating-current for railway work until recently, and that those who supported it abroad advocated the use of three-phase currents until within the last few months. Since my announcement of the principles of my system before the Great Barrington Convention, the development of the single-phase alternating-current railway motor has made remarkable strides, both in this country and abroad, and while at that time it had few friends the development has been such since, that it now seems destined to take its place as the leading railway motor, thereby effecting a revolution in electric railway work.

Many of your readers also know that, since announcing the principles of my system before the Great Barrington Convention, I have refrained from giving out any further information regarding it, giving as my reasons therefor my desire to test the system thoroughly before making further public statements regarding it, and then to present a full and complete description of it, together with the results of its operation, in the form of a paper before the American Institute of Electrical Engineers. Consistently pursuing that policy I have conducted my experiments privately and at my own expense, and had so perfected my apparatus that I had hoped to be able to celebrate the incoming of the year 1904 with a public demonstration, over 20 miles of railroad, which would conclusively prove that the single-phase electric railway is not only operative but efficient, and less in first cost and operation than any system now in vogue, not meaning to imply thereby that the system which I have developed was necessarily the only system or the best system, for only time can prove the correctness or incorrectness of such statements, but that it was a system which would successfully do the work, and the system which was first developed and first to be put in actual operation upon the first electric railway in the world, especially built for single-phase alternating-current motor operation.

That I would have made a demonstration on January 1 was a certainty to me until December 18, when I learned by telegraph, while in New York, that the car houses, located at Lansing, Mich., of the road upon which I had been experimenting, were completely consumed by fire at 4 o'clock that morning. The fire apparently originnated from a stove in the engine house, and was communicated so rapidly to the car houses that it destroyed a steam locomotive and two new cars built for my system, as well as my experimental locomotive, thus leaving me unable to make the demonstrations as I had planned. In view of the fact, however, that the single-phase electric railway is now receiving so much attention at the hands of engineers and inventors in many parts of the world, and that I believe that the year 1904 will be an epoch-making one, marking the revolution from the direct-current to the alternating motor for railway work, as well as the beginning, on a large scale, of the displacement of the steam locomotive on railways by the use of a substantial form of overhead construction rather than the third rail, and from the further fact that I cannot get another machine ready in the near future, I have concluded that I will give to the technical press a record of my work up to the present time, in order that it, and the system which I have developed, may be properly weighed in comparison with the work and systems of others, leaving the more complete description of the system and the results of its operation to be presented at a later date before the American Institute of Electrical Engineers.

In January, 1900, I rode over the country between Lansing and St. Louis, Mich., a distance of about 60 miles, with a party of gentlemen who desired to build an electric road between these points. This trip resulted in my advising them that the territory was such that I believed the road should be built as economically as possible, and, inasmuch as they desired me to assist financially in its construction, I told them I would do so provided I was allowed to construct the road in accordance with certain ideas that I then had in mind, for by such construction the first cost of the road could be kept sufficiently low to warrant its construction, and that if it were built on any one of the systems, standard at that time, the advisability of building it was questionable. The result was that on April 23, 1900, a contract was entered into wherein I undertook to build and equip the road. Engineers were at once placed in the field to locate it, and after the plans were sufficiently completed the grading, bridging and track work of 20 miles of the road followed, and this much of the road was completed, to such an extent, that steam trains were put in regular operation over it about November 15, 1901.

For financial reasons the completion of the road was delayed, and, in the meantime, the development of my system was taking place and the parts being perfected in different offices and shops.

Since it was my intention to experiment with pressure as high as 15,000 volts on the working conductor, all of the line material had to be specially designed, but the work progressed to such an extent that the overhead and line work of 20 miles of road was practically completed and ready for operation about December 15, 1902, and the power installed, so that experiments began in March, 1903. On June 15, 1903, two trips were made, each about 3 miles long, with my first experimental machine, shown in Fig. 8 of the accompanying description. On the first trip seven persons were carried, and on the second trip thirteen persons were aboard,

The result of the experiments with the first motor proved the correctness of the theory and that the machine would work. Inasmuch as it consisted of but one somewhat crude electropneumatic motor, it was impossible to get full and efficient tests of the system, and it was thought best to conduct no further experiments until a complete new double equipped truck could be perfected. Not being connected with manufacturing establishments I have been compelled to develop this system under trying circumstances, necessitating the construction of parts in different shops and assembling them at far distant points with crude facilities. This fact, combined with the financial difficulties that have arisen, and the necessity of my having to give the main part of my attention to other matters, have been the causes of the delay in completing the road and the system.

A new double-motor equipment, in the form of a locomotive, was finally built and brought to perfect working condition on the evening of December 17, and it was this locomotive with the necessary instruments for testing purposes that was destroyed by fire the following morning. Since it is going to be impracticable for me to get a new one constructed for some time, I have thought best to state the facts as outlined above, and give to the technical press a description of the apparatus and the road, reluctantly omitting the records of operation and the tests which I had hoped to have accompany any future statements I made, but which, through "the irony of fate," must now be left for the future. Below will be found some particulars of the road and system:

ROADBED AND TRACK.

The Lansing, St. Johns & St. Louis Railway was originally projected to extend from Lansing, the capital of Michigan, northward through St. Johns, Alma and St. Louis, a distance of about 60 miles, but up to the present time only that portion extending from Lansing to St. Johns, a distance of 20 miles, has been constructed.

This road was built in accordance with steam railroad practice, with easy grades and curves, so that steam locomotives could be operated over it until such time as electrical equipment could be put upon it; the idea being to complete the road in such a manner that it could be utilized for both freight and passenger service, and thus secure all the business available from the territory through which it passes.

The road is equipped with 67-lb. T-rail, laid on ties spaced 2 ft. apart between centres, and as alternating high-tension current was to be used but one of these rails was bonded with 38-in. 0000 bonds, extending entirely around the splicebars.

Since it was impossible to secure rails from the rail manufacturers in time, rails and splice bars were secured from one of the leading steam railways, and this necessitated the adoption of a supported joint and a long bond, as there was not room under the splice bars for concealed bonds.

The road as at present constructed between Lansing and St. John has no grades exceeding 1 per cent, and no curves exceeding 7 degs., except in the cities themselves, where the terminals of the road run over the streets and make such curves as ordinary street cars make, the minimum radius being 50 ft. At each city a terminal was planned

so that all freight would be diverted to connecting steam roads, thus making it unnecessary for the freight service to pass over the city streets or curves.

At the Lansing end it was necessary to pass over the steam railway tracks of the Pere Marquette Railroad, and this necessitated the construction of a bridge with pile approaches. The grade, as approached from the Lansing end, being 4 per cent for a distance of about 700 ft., and after passing over the bridge the descending grade is 2.3 per cent for about 500 ft. At the St. Johns end there is a grade on the principal street of the town averaging about 2 per cent for about 1,500 ft.

OVERHEAD CONSTRUCTION.

Considerable care was taken in planning a suitable insulator for carrying the trolley wire, and Fig. 1 shows the construction of the annealed glass insulator used.

Fig. 2 shows a typical arrangement of the straight line overhead construction, and it will be noticed that wood is used for the pole, cross-arm and braces, and that the insulator is supported by means of a short span wire from iron brackets secured to the wooden cross-arm. This construction insured a high insulation at a low first cost, the entire line having been constructed for but a slightly increased expense over the cost of standard construction, and at the same time so built that in case of failure of the alternating-motor system the standard direct-current motor system could be put into service without changing any parts. Even holes for the pins for carrying the extra feeders which would be required were provided, as shown.

It will thus be seen that the line and track work were constructed in such a manner that no expense was incurred for any parts which would not be required for standard construction in case it became necessary to ultimately adopt the standard direct-current motor system; the entire idea in the construction of the road being to save first cost and to invest all that was invested in such a manner that all material purchased would be utilized in case either system were adopted, and should the alternating system prove successful the additional investment for a direct-current motor system need not then be incurred.

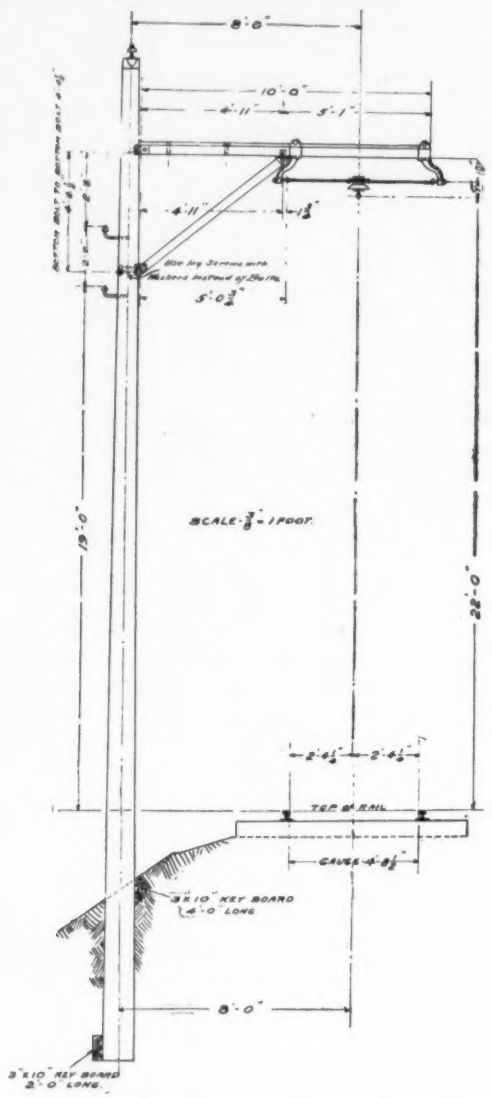


FIG. 1.—TYPICAL STRAIGHT LINE OVERHEAD CONSTRUCTION.

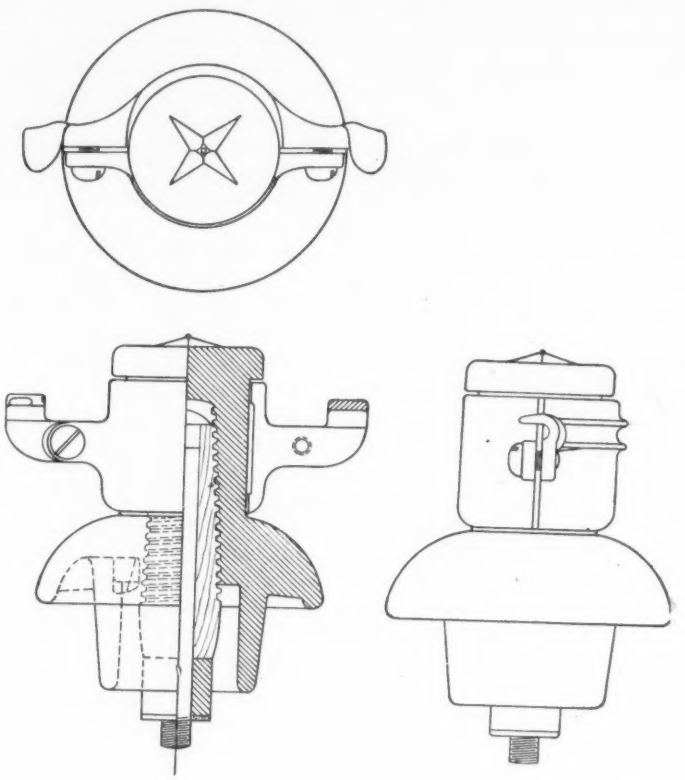


FIG. 2.—SPECIAL INSULATOR USED.

The working conductor was placed 22 ft. above the top of the rails in order that trainmen, when standing upon the tops of the freight cars going over the road, could not come in contact with the working conductor.

It was planned to operate the entire road from a single 00 trolley wire, and with one rail bonded as hereinbefore mentioned; this amount of copper being sufficient to operate four 40-ton cars at an average speed of 30 m. p. h., with power house located 1½ miles from one end of the line, and operating with from 6,000 volts to 10,000 volts on the working conductor.

The power house is located at one end of the line, owing to the electric company, from which power is purchased by the railroad, having a water power at this point. Current is transmitted to the nearest end of the line over two No. 3 wires. The power is furnished from a 300-kw rotary converter, generating at 380 volts at 25 cycles, the energy from which is stepped up to the working pressure of the line. It was the intention, after experimenting a sufficient length of time to determine the best voltage for the working conductor to have the generators for the permanent plant constructed so as to generate at this determined voltage, and it was for this reason that a temporary rotary converter was first installed to conduct the experiments with.

During the preliminary experimental period upon the apparatus, hereinafter described, all power was transmitted from the above-mentioned power house to a point about 2 miles distant, where were located the car houses in which the preliminary experiments were made.

The conditions under which the first application of the system took place having thus been set forth, it may be well, in order to get clearly before the reader, the principles on which the system is based, to quote here the statements made by myself before the Great Barrington Convention on June 19, 1902, as follows:

"The principles underlying the system I advocate, and which I call an electro-pneumatic system, are as follows:

"1. A single-phase or multi-phase motor, mounted directly upon the car, designed for the average power required by the car, and running continuously at a constant speed and a constant load, and, therefore, at maximum efficiency.

"2. Instead of stopping and starting this motor and dissipating the energy through resistances, as is customary with all other systems known to me, I control the speed of the car by retarding or accelerating the parts usually known as the rotor and stator of the motor, by means of compressed air, in such a manner that I save a portion of the energy which is ordinarily dissipated through resistances, and store it to assist in starting the car, helping over grades, for use in switching purposes and for the operation of the brakes.

"3. By this method of control I secure an infinite number of speeds from zero to the maximum speed of the car, which may or may not be at the synchronous speed of the motor, for with the air-controlling mechanism working compressing, the speeds below synchronism are maintained, and by reversing the direction of the air through the controller speeds above synchronism may be attained for reasonable distances. This feature gives to the alternating-current motor the element absolutely essential for practical railway work, for it permits a car or train to ascend a grade at any speed with the motor working at its maximum efficiency and imparting its full torque to the car. When descending the grade the motor may utilize its full power drawn from the line in compressing air, or it may be used to compress air with the stored energy of the train, thereby acting as a brake.

"4. By virtue of the air storage feature each car becomes an independent unit, and capable, in case of loss of current from the line, of running a reasonable distance without contact with the working conductor. This feature will enable a car to work on a high-tension trolley wire or active conductor over private right of way, and allow the active conductor to be stopped where the private right of way ceases, and the car to proceed through a city or town on any tracks, whether electrically equipped or not, until it reaches the outskirts of the city or town, where it can take up the working conductor again on private right of way. This feature is also valuable in switching work, for each car being independent it can leave the main line track and operate over switches or sidings without complicating the yards with additional overhead or third-rail conductors, thus necessitating through-line conductors over main-line track or tracks only.

"5. Since a single-phase motor can be used the motors can be supplied with current from a single overhead wire or third rail, and with a single-rail return circuit, thus permitting the overhead construction, or third-rail construction, to conform to the standard of to-day, except that a much higher working voltage can be used, provided the insulation is taken care of. Furthermore, in steam railway work this system, by virtue of its single-phase features, will only require the use of one of the track rails for the return circuit, thus leaving the other rail for the use of the signal system, which, up to the present time, does not seem to have been satisfactorily solved without the use of one of the track rails.

"6. The current will be taken from the working conductor at any voltage up to the limit of the insulation, and in case this voltage is high (I am building my line for 15,000 volts), a static transformer will be carried upon each car and the pressure reduced from the line voltage to the voltage of the motor, which, in the case under construction, is designed for 200 volts. Where it is unnecessary to utilize so high a line pressure the motor may be designed for the working voltage, and the current fed directly from the working conductor into the motor, thus eliminating the static transformer. When a high-voltage working conductor and static transformer is used, and it is thought advisable to use a working conductor through cities or towns, this working conductor will be supplied with energy through a stationary transformer at each city limit, thus making the working conductor through the cities or towns safe.

"7. By virtue of the speed of the motor and its constant load, either when the car is in motion or when it is standing still, and the motor is compressing air, the variable load now customary in electric railway power plants is eliminated, and the power station works at practically a constant load, thereby eliminating a large part of the investment at present requisite in power station and line construction. Furthermore, by virtue of the air storage feature each car, in the particular apparatus I have designed, is capable at any time when current is on the working conductor, of delivering to the car wheels a much greater torque in proportion to the capacity of the motor than is possible with any electrical system known to-day.

"I believe that by the adoption of this system the following results will be accomplished:

"1. The entire elimination of the present standard system of rotary converter substation plant, together with the maintenance thereon, and the cost of the necessary attendants.

"2. The absorbing and rendering available for useful work in starting, or otherwise, a large percentage of the energy stored in the moving mass, which, under the present methods of operation, is dissipated at the brake-shoes.

"3. A large reduction in the first cost of electrically equipping long-distance railroads, thereby making it feasible, from an engineering and business standpoint, to equip many roads which cannot now be shown advisable, thus opening up the steam railway field to the industry in which we are now engaged."

The following description will explain more in detail the application of the principles of the system and the mechanism of its working parts:

Fig. 3 represents diagrammatically the working parts of one form

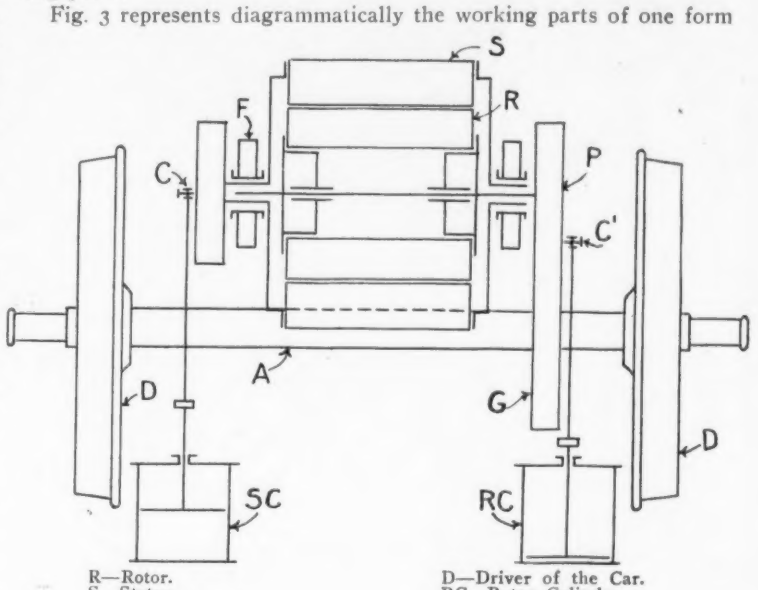


FIG. 3.—DIAGRAMMATIC ARRANGEMENT OF ELECTRO-PNEUMATIC MOTOR.

of the system. The rotor *R* of a single-phase induction motor is geared to the axle of the car, and by means of crank pin, *C'*, secured in pinion *P*, also drives the compressor cylinder *R C*, while stator *S* can freely revolve around the rotor and drive by means of crank pin *C* the compressor cylinder *S C*. Both cylinders are piped to air reservoirs located under the car, and are also provided with suitable valve manipulated from a single controller on the car platform for making them perform their various functions, thus the entire regulation of the speed and power of the car are controlled by the air cylinders, and no other regulating devices are necessary. The cylinder valves are electrically operated, which makes it possible for each cylinder, when driven by the electric motor, to compress air into the tanks, and when operated by compressed air to furnish mechanical energy for moving the car. When, for instance, the cylinder is compressing air the valves work like inlet and outlet poppet valves of a common air pump, while on the other hand if the cylinders are supplied with compressed air each valve is operated electrically by a pilot solenoid connected with the valve seat in such a manner that the energy for moving the valve is supplied by the compressed air, thereby making the valve practically self-actuating. The time of operation of the valves is controlled by a series of collector rings revolving with the engine shaft, and their regular operation is interrupted and varied to suit the requirements by means of the motorman's controller.

When a rotary or turbine type of air engine is used all of the above valves and reciprocating parts are eliminated and the entire controlling mechanism consists of two air valves, operated from a single engineer's valve, which may be located upon the platform of the car or in the cab of the locomotive, and so arranged that one or more units may be operated from the platform of the cab of any unit without the necessity of connecting wires between the units.

Since the motor may be of the simplest types of induction motor without a commutator, and the system does not require the manipulation or breaking of the main current the motor may be designed for any working voltage, and be of any type which will maintain a con-

stant speed when provided with a constant load. This eliminates the necessity of all step-down transformers, resistances or other regulating devices and confines the current to the motors themselves, and as these are below the car floor the danger from the current is reduced to the minimum.

At the same time the air cylinders, in addition to performing all the functions of speed control, give to the machine the independent unit element, and the ability to store the kinetic energy of the train in stopping and utilizing it in starting. On account of these and other features the electric motors of this system can be much smaller in capacity when rated as continuous working motors, than those of other systems not possessing this equalizing load feature, and the capacity of the power house and line can be reduced to about one-half of what would be required with systems where the fluctuating starting loads of the cars are transmitted back to the power house.

In order to better understand the different operations of the system, Fig. 4, showing a speed diagram, has been prepared, in which,

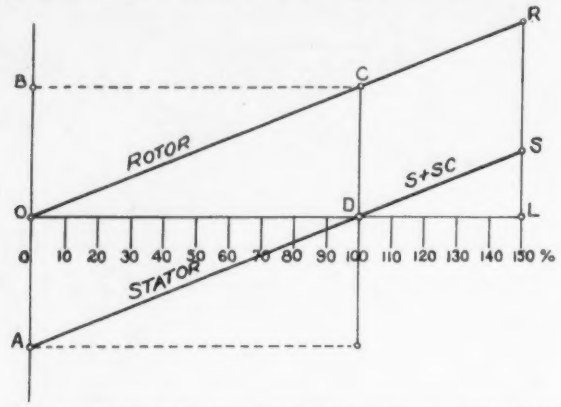


FIG. 4.—DIAGRAMMATIC REPRESENTATION OF OPERATION.

on the axis of abscisse, *O D L*, are represented the different car speeds in per cent of the synchronous motor speed, while the co-ordinate axis, *A O B*, represents the rotor and stator speeds corresponding to the car speeds shown.

The operation of the car may be divided into the following periods:

1. STANDING IN THE STATION.

Referring to Fig. 3 the rotor *R* is standing still, while the stator *S* runs with full synchronous speed. The stator is then transferring the full energy of the electric motor through crank *C* to the compressor cylinder *S C*, which energy is being delivered in form of compressed air into the air reservoir.

Since the relative velocity between the stator and the rotor is, under all conditions of operation, constant, the speed curves of stator and rotor may be represented by two parallel lines, *O C R* and *A D S* in Fig. 4. The origin *O* of the given co-ordinate system represents the period of rest of the car, and, therefore, indicates zero rotor speed and full stator speed in a negative or downward direction, as the stator is now revolving in the opposite direction from that which the rotor must revolve to drive the car forward.

Let it be further assumed that for an instant *O A* equals the active torque of the stator, then it will be easily understood that *O B*, which equals *O A*, represents the reactive torque of the rotor exerted on the car axle, meaning that if the car is free to move the reactive torque can be used advantageously for the starting and acceleration of the car.

When the car is standing in a station it is held at rest by moving the controller to such a position that the outlet pipe from rotor cylinder *R C* is throttled, thereby increasing the pressure behind the piston to such an extent that it overcomes the effort of the rotor *R* to revolve, thus tending to cause the stator *S* to revolve and at the same time holds the car at rest without the use of wheel brakes.

2. STARTING AND ACCELERATING.

To start the car the air cushion behind the piston of *R C* is removed, and the air, which is being compressed by cylinder *S C*, supplemented by the stored air from the tanks, is admitted to cylinder *R C*, with the controller at the position of maximum cut-off. The rotor then begins to revolve, and as it accelerates the stator slows down by exactly the same amount that the rotor has increased its speed, and as the rotor and car speed increase the controller is gradually moved to a smaller percentage of cut-off, until the car speed corresponds to the full synchronous speed of the motor, at which time the stator comes to rest.

During this period of acceleration the air compressed by cylinder *S C*, instead of being delivered to the tanks to lose its heat, is delivered, hot, directly to the rotor cylinders, thus greatly increasing the efficiency of the combination, as the heat usually lost in air systems is utilized, and the advantages of heated air gained without a reheater, and as the pressure used is low many of the ordinary difficulties in the use of compressed air disappear. If the rate of acceleration is such that cylinder *R C* uses all of the air supplied by cylinder *S C* no exhaust to the atmosphere from cylinder *R C* takes place.

Referring now to Fig. 4, which graphically represents this process, since the electric motor runs always at a constant speed and a constant load, it has a constant torque, and, therefore, the distance between lines *O C R* and *A D S* may be considered as representing the energy delivered by the electric motor.

The length of any ordinate extending from *O D* to *O C* represents the proportionate amount of energy derived from the electric motor, which is applied directly through pinion *P* and gear *G* of Fig. 3 to the propulsion of the car, while the corresponding ordinate extending below *O D* to *A D*, represents the proportionate amount of the energy of the electric motor, which is absorbed in compressing air through cylinder *S C*, which energy, in the form of air, is immediately transferred to cylinder *R C*, and is utilized in accelerating the car.

In practice, however, since there will be a loss in transferring the energy from electrical energy to energy in the form of compressed air and back again into mechanical energy, this loss, whatever it may be, must be drawn from the storage tanks, and the requisite amount of air from these tanks supplied to rotor cylinder, *R C*, in order to maintain the full power of the electric motor upon the car axle during the period of acceleration. Should it be desired to accelerate at a greater rate than the full power of the electric motor is capable of giving to the car the additional energy may be supplied in the form of air from the storage tanks through cylinder *R C*, thus increasing the total energy given to the car during acceleration, in which case this total power would be represented for any given instant by a point above line *B C*.

3. FULL SPEED.

When the rotor has reached full synchronous speed, by the previous operation, this speed can be maintained by moving the controller to another position, which will throttle the outlet pipe of cylinder *S C* until the reaction due to the pressure behind the piston equals the full capacity of the electric motor. An overload or underload may be placed upon the motor by varying this pressure, but under normal conditions of operation cylinder *S C* is provided with an automatic valve, which keeps a constant pressure behind its piston, thus maintaining an absolutely constant load upon the electric motor, and consequently a uniform demand of electrical energy from the line. This uniform load is represented by the parallel lines *O C R* and *A D S* of Fig. 4.

With the controller set at full-speed position the inlet valves of rotor cylinder *R C* are held open and the piston runs free and the electric motor now gives its full power to the car axle, and the stator and its air mechanism will remain at rest as long as the car runs at the speed corresponding to the synchronous speed of the motor.

4. SPEED VARIATIONS.

There are usually certain places on any road where high rates of speed can be maintained for short distances, and as these speeds might be higher than the synchronous speed for which the motor was designed they are provided for as follows:

Assuming that the car is running at synchronous speed the controller may be moved to such a position that the valves of stator cylinder *S C* operate in such a manner as to cause it to act as an engine and revolve stator *S* in the same direction as rotor *R* is revolving. This now causes, owing to the constantly electrically maintained relative difference in speed between the stator and the rotor, an increase of speed of the rotor and car axle, due to the motor automatically working as a magnetic clutch, without mechanical contact, and if the resistance of the car or train is less than the capacity of the electric motor, the air necessary for revolving the stator can be obtained, hot, from the rotor cylinder *R C* without drawing from the tanks, and a speed above synchronism indirectly proportioned to the resistance of the train maintained indefinitely. When the resistance of the train is greater than the capacity of the electric motor speeds above synchronism can be obtained only by supply rotor cyl-

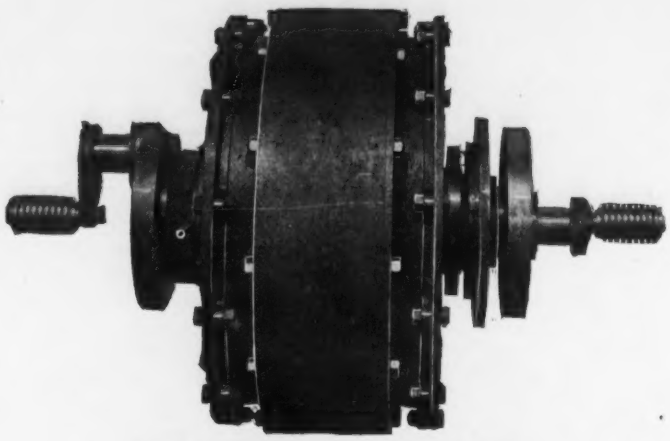


FIG. 5.—OUTSIDE VIEW OF ELECTRIC MOTOR.

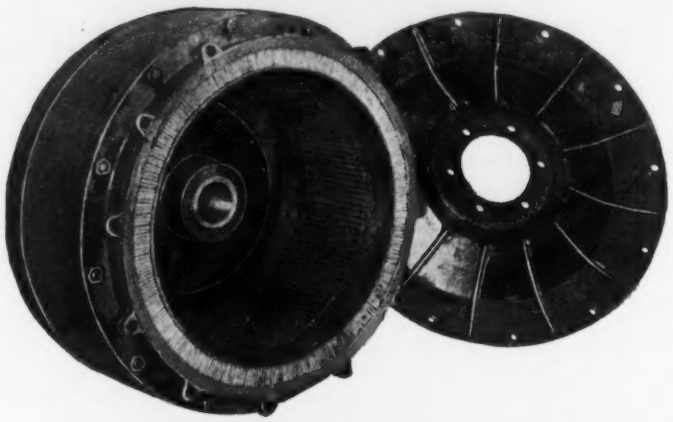


FIG. 6.—INTERIOR VIEW OF ELECTRIC MOTOR.

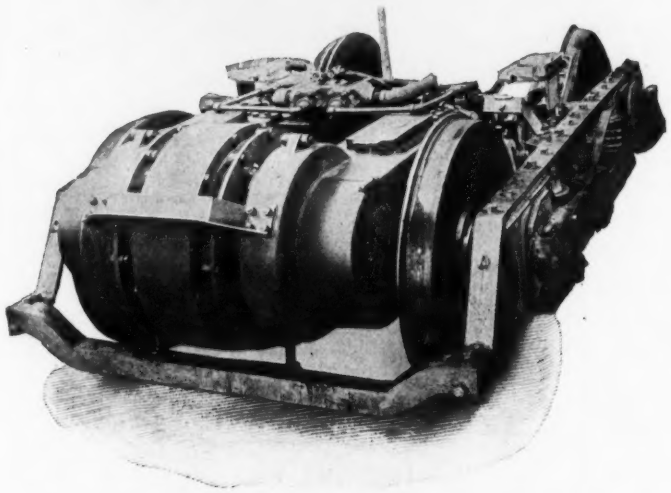


FIG. 7.—VIEW OF FIRST EXPERIMENTAL MOTOR WITH MOTOR FORWARD.

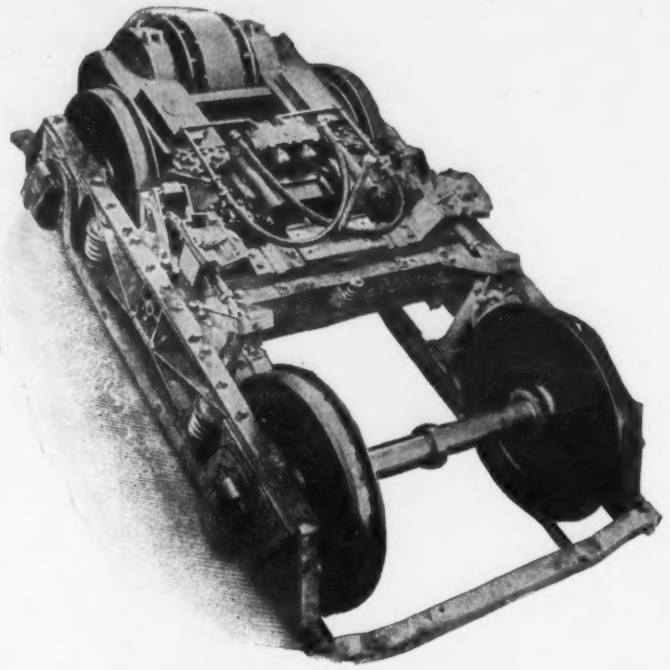


FIG. 8.—VIEW OF FIRST EXPERIMENTAL MOTOR WITH MOTOR IN THE REAR.

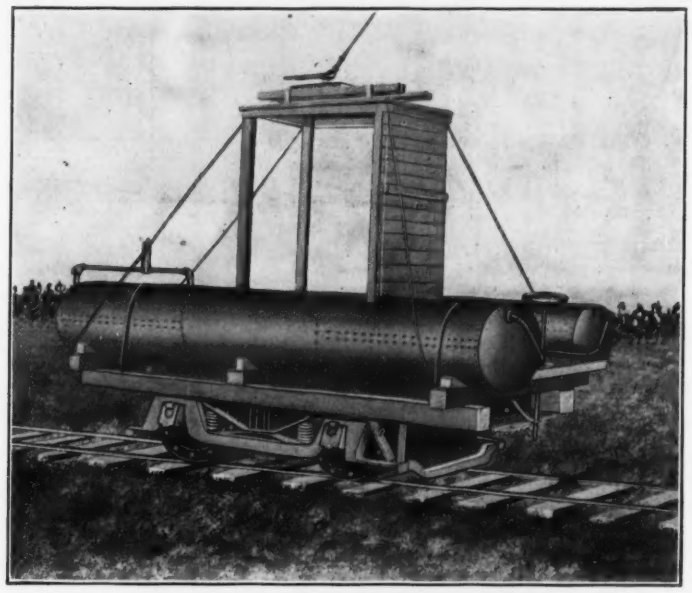


FIG. 9.—FIRST EXPERIMENTAL LOCOMOTIVE.

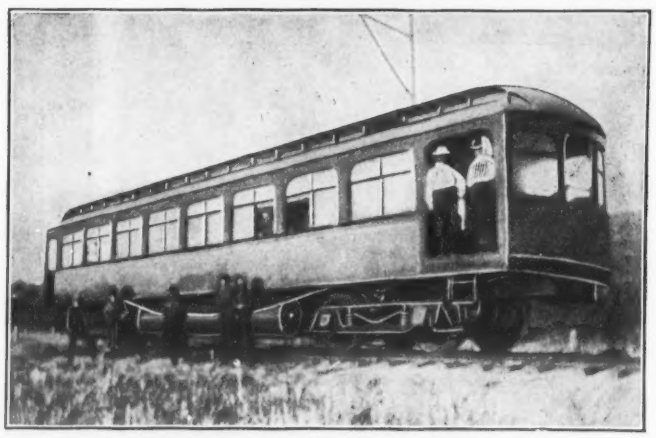


FIG. 10.—PHOTOGRAPH OF COMPLETE CAR.

FIG. 11.—CAR BARN AFTER FIRE.

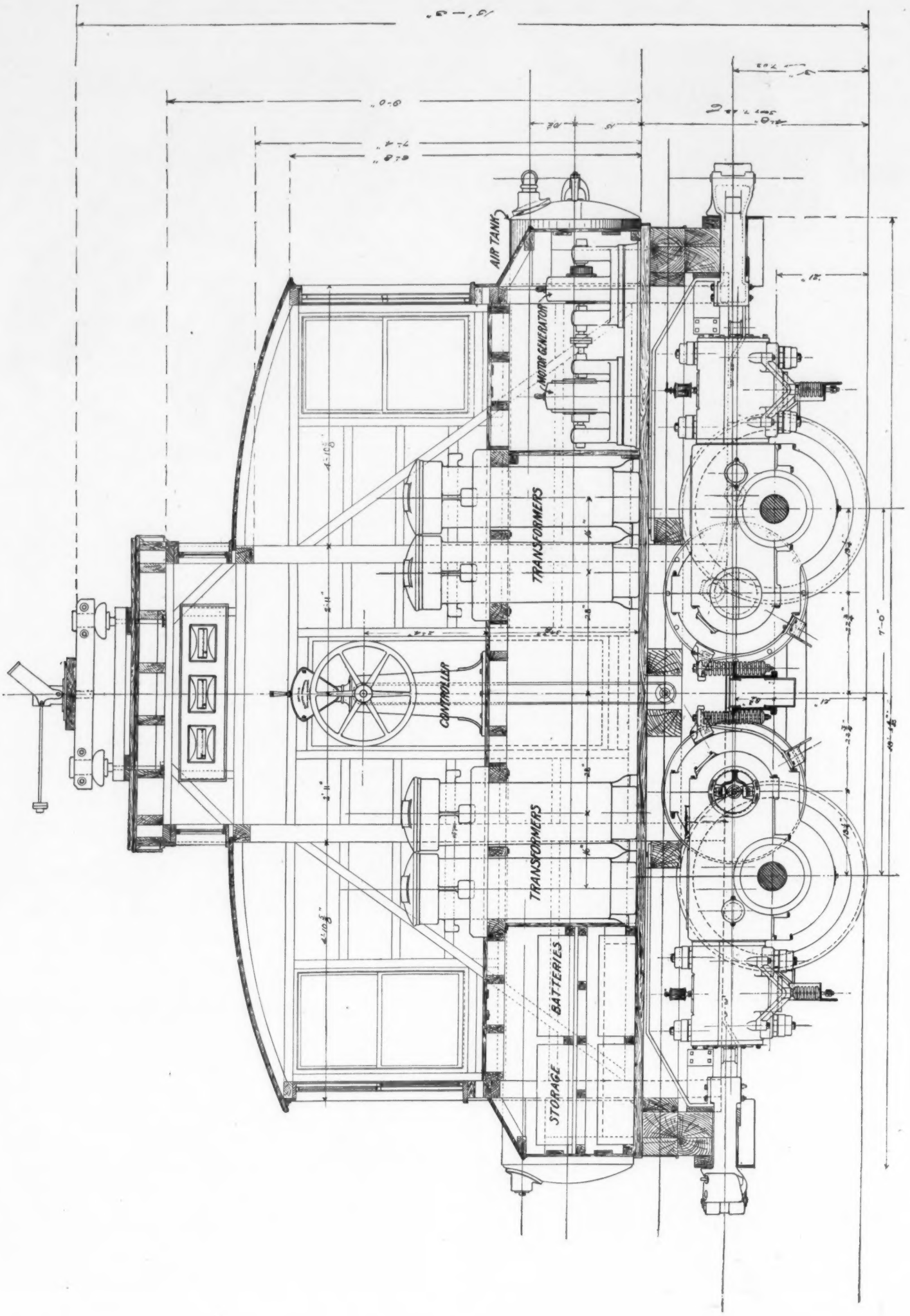


FIG. 12.—LONGITUDINAL SECTION OF LOCOMOTIVE.

inder *R C* with stored air from the tanks, and can only be maintained for short distances, or until the storage capacity of the air reservoirs is exhausted. This condition corresponds to the spurts that can be made by a steam locomotive when working above the steaming capacity of the boilers. The distance from the line *O D L* to that portion of the line *A D S* above *O D L* in Fig. 4 represents, at any given speed, the proportionate amount of energy which must come from the tanks, and be supplied through cylinder *S C*, and the distance from *D L* to *C R* represents the total energy given to the car by the combined action of the electric motor and the stator cylinder when operating under these conditions.

The energy delivered to the car can be still farther increased by admitting air into rotor cylinder *R C*, and allowing it to work as an engine.

5. RETARDATION.

To bring the car or train to rest, instead of applying mechanical brakes to the wheels in the ordinary manner and thereby dissipating the entire stored energy of the car or train in the form of heat, this energy is saved in the form of compressed air, to assist in starting the car or train, by setting the controller in such a position that rotor cylinder *R C* compresses air and delivers it into the storage tanks. Any desired rate of retardation can be secured by throttling the delivery pipes from rotor cylinder *R C*, and in practice this pipe is provided with an automatic valve, which releases just before the slipping point of the wheels, thus allowing the motorman to brake as rapidly as he desires without liability of flattening the wheels. Supplemental wheel brakes are provided for emergency, but need not often be used, and the ordinary wear and tear on them is saved. When the car is again at rest the cycle of performance as above given is repeated for the next run.

6. REVERSING.

When it is desired to run the car backward for short distances the electric motor is not disturbed and the power is furnished by the rotor cylinder, *R C*, by reversing the action of the valves; but if it is desired to run backward for any great distance, the current is thrown off the motor, the stator engine reversed, and the stator brought to speed by the air, when the current is again thrown onto the motor, and the cycle of operation is the same as when running forward.

Fig. 5 represents the exterior of the electric motor, showing the cranks of the stator and rotor, also collector rings for operating the valves of the air cylinders when working as engines.

Fig. 6 shows an interior view of the stator of the motor with the flange removed, the rotor of the motor being of the standard squirrel cage induction type.

Figs. 7 and 8 show, mounted upon a track, two views of the first electropneumatic motor constructed, and upon which the first experiments were conducted, while Fig. 9 shows the same truck and motor placed underneath one of the care constructed for the system, the design of which is shown more clearly in Figs. 10 and 15.

Since the single motor represented in Figs. 7 and 8 was too small in capacity to propel so large a car, it was decided to experiment with an improvised locomotive, consisting of the truck and motor shown in Figs. 7 and 8, carrying suitable air tanks and transformers upon a temporary frame structure. This locomotive, shown in Fig. 9, was the one upon which the trial runs were made and passengers carried on June 15, 1902.

Figs. 16 and 14 show the end and side views of the new electropneumatic motor constructed after the preliminary experiments had been made on the first motor. For experimental purposes this truck was fitted up in the form of a locomotive, as shown in longitudinal and transverse section by Figs. 13 and 14, and it was this locomotive that was recently destroyed by fire. In order that the locomotive might operate as an independent air unit upon tracks not equipped with overhead electrical conductor, it was provided with a small storage battery and small motor generator for charging the batteries, and for operating the headlight. These auxiliaries are not necessary for the successful operation of the system, provided the locomotive can always be supplied with electric current from the working conductor, for then the valves can be made to operate from alternating current, and thus eliminate the use of motor-generator and batteries. When, however, it is desired to operate independently of the electric conductor these auxiliaries are necessary, and one set may supply an entire train. It will be seen that the locomotive is also provided with transformers, another auxiliary which is unnecessary in case the motors are designed for the voltage transmit-

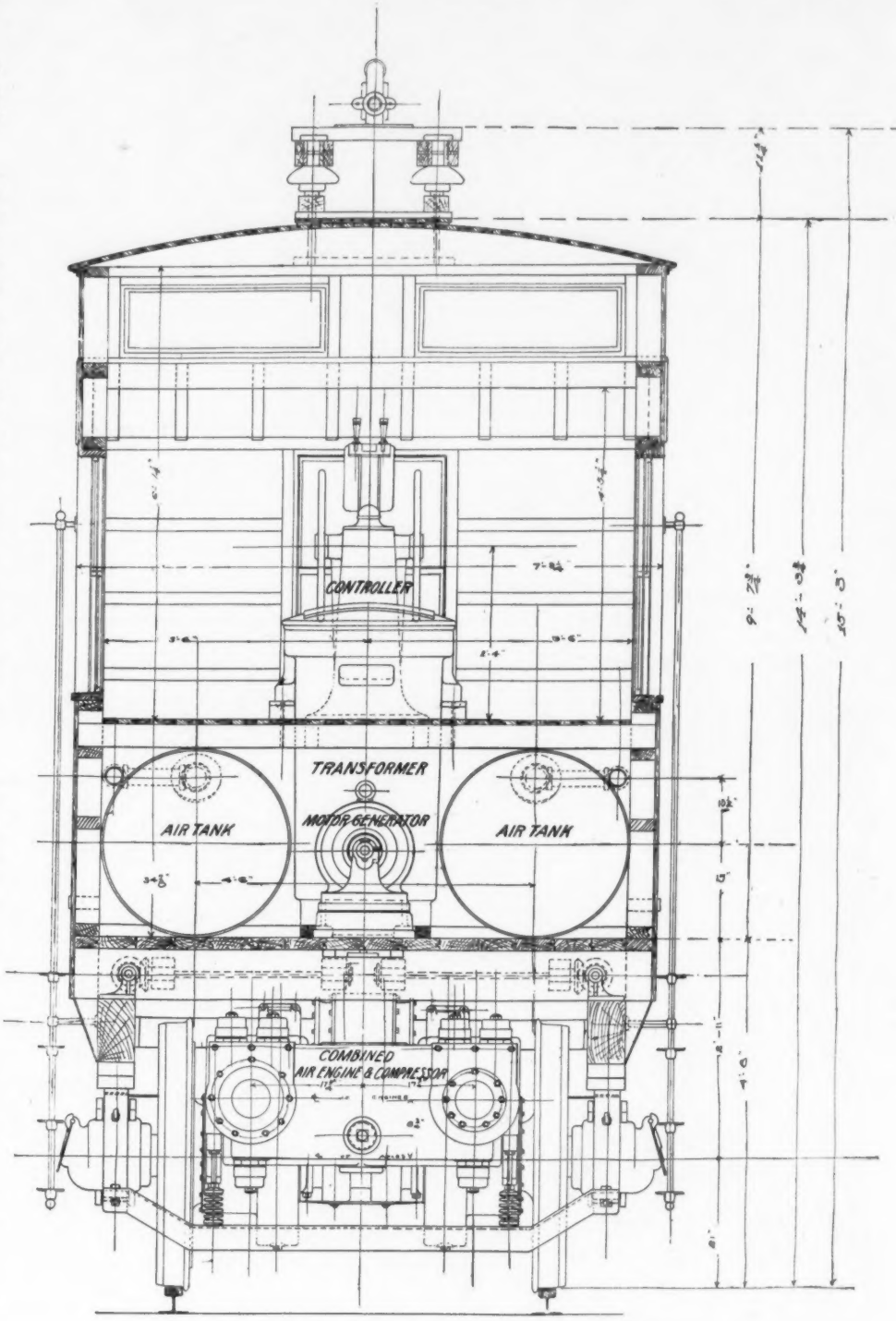


FIG. 13.—TRANSVERSE SECTION OF LOCOMOTIVE.

ted over the working conductor, but in this case transformers were used because the manufacturer of the motors could not be induced at the time they were purchased to build a high-tension motor for railway work, consequently the parts of a standard motor were utilized,

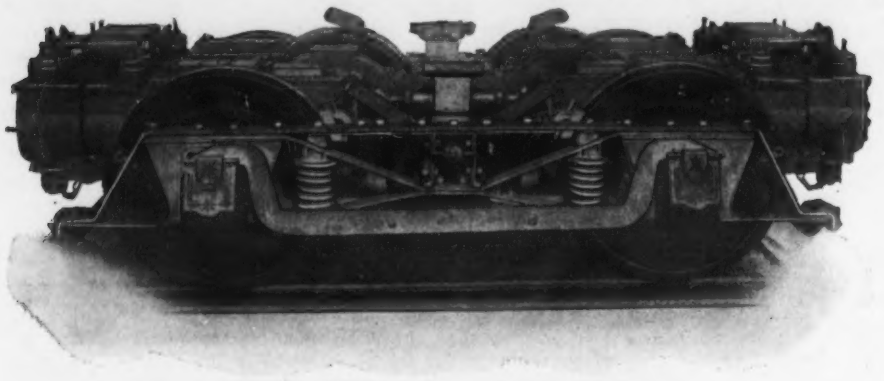


FIG. 14.—SIDE VIEW OF LATEST MOTOR EQUIPMENT WITH TRUCK.

and a pressure of 200 volts adopted for the motors, as this was the most economical voltage that could be used with the particular parts selected. This locomotive was provided with all necessary testing instruments, and had been operated in the car houses for some time,

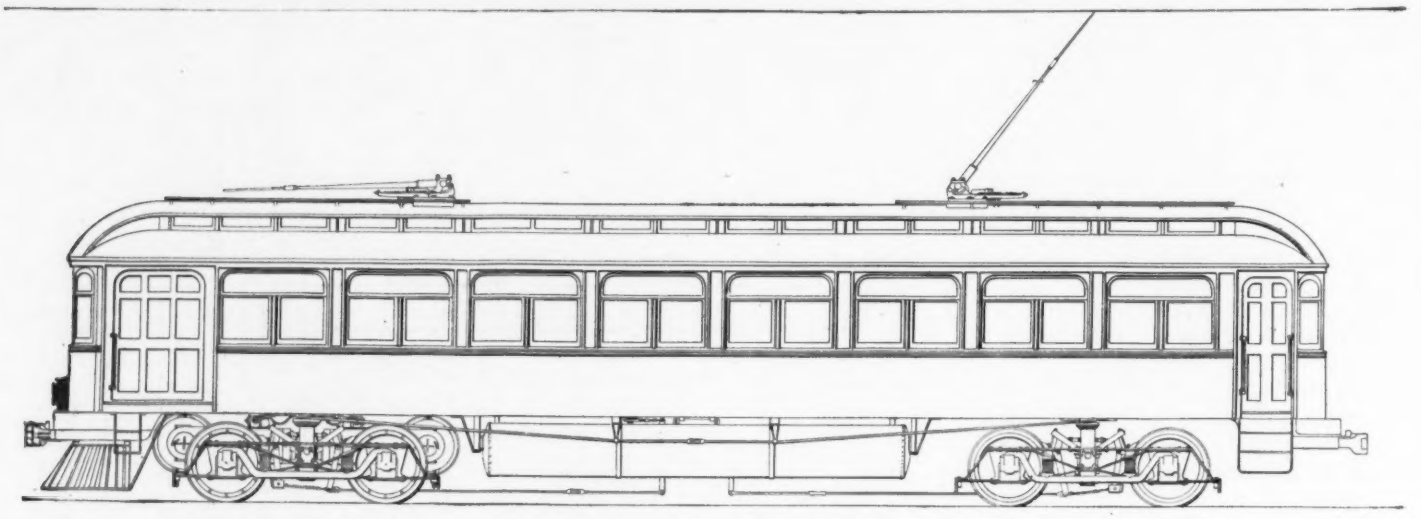


FIG. 15.—DRAWING OF COMPLETE CAR.

and found to perform all its functions successfully, and would have been placed on the road, and experiments with it would now be in process had it not been destroyed. All that remains of it is shown

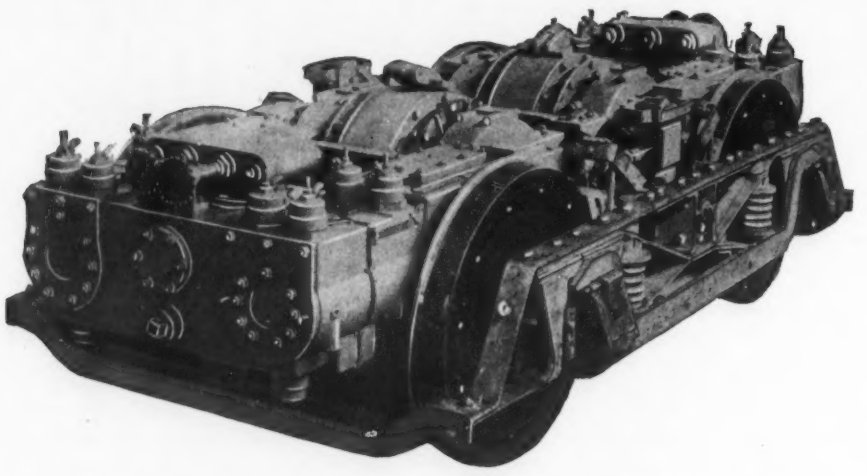


FIG. 16.—END VIEW OF LATEST DOUBLE MOTOR EQUIPMENT WITH TRUCK.

in Fig. 11, taken from a photograph of the site, the lumber shown having been carried to the site after the fire to shelter the machine with.

The Curies and Radium.

In a recent article in the New York *Independent*, about the Curies, Mme. Beinstock tells of the trials which the young French couple had before they gained fame. At the start the material situation of the young couple was not very bright. Neither had any fortune, and with the few thousand francs which they earned it was no easy task to make both ends meet at the close of the year in such an expensive city as Paris. So they went out into the suburbs of the great capital and established themselves in the little town of Bourg-la-Reine, distant two or three miles from the walls; and in order to save the railway fare, husband and wife, in all weathers and at all hours, made the journey by bicycle from their modest lodgings to their laboratory in the dingy old Rue Lhomond, where they have made their important discoveries. When it is known that the road from Bourg-la-Reine to Paris is block paved much of the distance and encumbered in many ways, these goings and comings on "the wheel" were not holiday rides, especially in the case of the frail young wife.

Soon a child came to the struggling couple. The little daughter is now seven years old, in good health, full of life and tenderly cared for by the loving mother. So Mme. Curie is not only a scientist, whose name is well known throughout the world, but a model wife and mother, another and most striking example of the fact that the new woman does not differ in this respect materially from her sister.

The prize of 100,000 francs ($20,000) placed at the disposal of the Parisian press syndicate by M. Osiris has been divided between Mme. Curie, to whom 60,000 francs ($12,000) has been allotted, to enable her to continue her researches as to radium, and M. Branly, who received 40,000 francs ($8,000) for his discovery of the conductibility and non-conductibility of filings under the influence of the Hertzian waves, which rendered wireless telegraphy possible.

Mme. Curie has contributed an interesting article to the January *Century Magazine*, in which she discusses the subject of radium and makes a number of interesting and important statements and deductions based upon her own experiments and observations. The article was in all probability written several weeks ago, since which time, as our readers know, a good deal of new work has been done in the field; but it is none the less well worth reading. Prof. Ernest Merritt, of Cornell University, has also in the same issue an article on the subject, which will also enlighten and instruct the general public.

Water Power Electrical Generating Plant at Riva, Tyrol.

BY FRANZ KOSTER.

RIVA, a city on Garda Lake, in the Tyrol, and much frequented by tourists, possesses a water power electrical generating plant of unusual interest in view of the fact that the total population served, including that of Varone and St. Giacomo, neighboring towns, is less than 8,000. When it was decided to put down a plant several water powers presented themselves for consideration. The city is within easy distance of the Albole, a small stream with a fall of 650 ft., and the Varone, with a fall of 327 ft. As these, however, were already largely occupied for commercial and supply purposes, it was determined to use the Ponale, which, though having a fall of only 200 ft., is larger and more available and from which may be utilized a water power of 2,000 hp.

The station has been erected in two parts; the second, just finished, having been commenced upon the completion of the first part. A third portion will be erected as soon as the necessity for the power arises. The portion first erected contains dynamos and turbines of double the power of those of the first part. The plant was designed and erected by the Maschinenfabrik Oerlikon, of Zurich, Switzerland.

The Ponale, which has a minimum flow of 500 gallons per second, connects Lago di Ledro, a natural reservoir fed from springs, with Lago di Garda, 2,000 ft. lower and some 10.5 miles away. In addition the Ponale is fed on its course by many small tributary springs. The principal power reservoir lies 285 ft. above the level of the Lago di Garda and is firmly constructed of iron and masonry. To this reservoir from a convenient point on the Ponale the water is fed, first through an open canal 115 ft. long, 6.56 ft. deep and 7.25 ft. wide, then through a tunnel through solid rock 787 ft. long, then in an open canal 26.25 ft. long, and finally through another tunnel 50.4 ft. long. These tunnels, which can be entered for inspection and open canals, were required on account of the necessity of carrying the water across ravines and through the mountain "Val de Ledro." From the reservoir the water finds egress into the penstock, which has on its water inlet a strainer-head over which is fitted a removable finely-perforated hood. At one side provision is made for the overflow and a drainage canal.

The penstock leading to the central station is 557 ft. long and of riveted steel plates with a diameter of 2.4 ft.; it is above ground through its entire length, lying on a steep rocky slope and supported on masonry and steel piers built on the native rock. Arrangement is made for the erection of two other similar penstocks when necessity arises, parallel to the present one and on the same foundations. The penstock supports are constructed to allow such slight movement as is caused by expansion. Two expansion joints have been inserted for the necessary purpose. At the foot of the penstock, which is strongly constructed, a branching occurs, leading through a canal blasted from solid rock to the portion of the power house first erected. One branch of the penstock leads to the three turbines first installed, while the other leads to the two turbines in the next room. These branches are provided with double safety and discharge sliding valves, and the turbines may be shut off by by-pass sliding valves.

FIG. 2.—RIVA POWER STATION.

The power house, which is, as stated, in the immediate vicinity of the Ponale Falls, is 2.17 miles from Riva, and lies 165 feet above the level of the Lago di Garda. It is picturesquely situated on the mountainous slope of the "Val de Ledro." The building is of brick and rough stone work with a roof frame of iron and wood carrying a terra cotta roof. The main floor of the power house is divided into two parts. The original portion contains a room for the three 150-hp. turbines and dynamos, and four rooms for the occupancy of those in charge of the operation of the plant; in the addition is a machine room for the 300-hp generators and a room for apparatus.

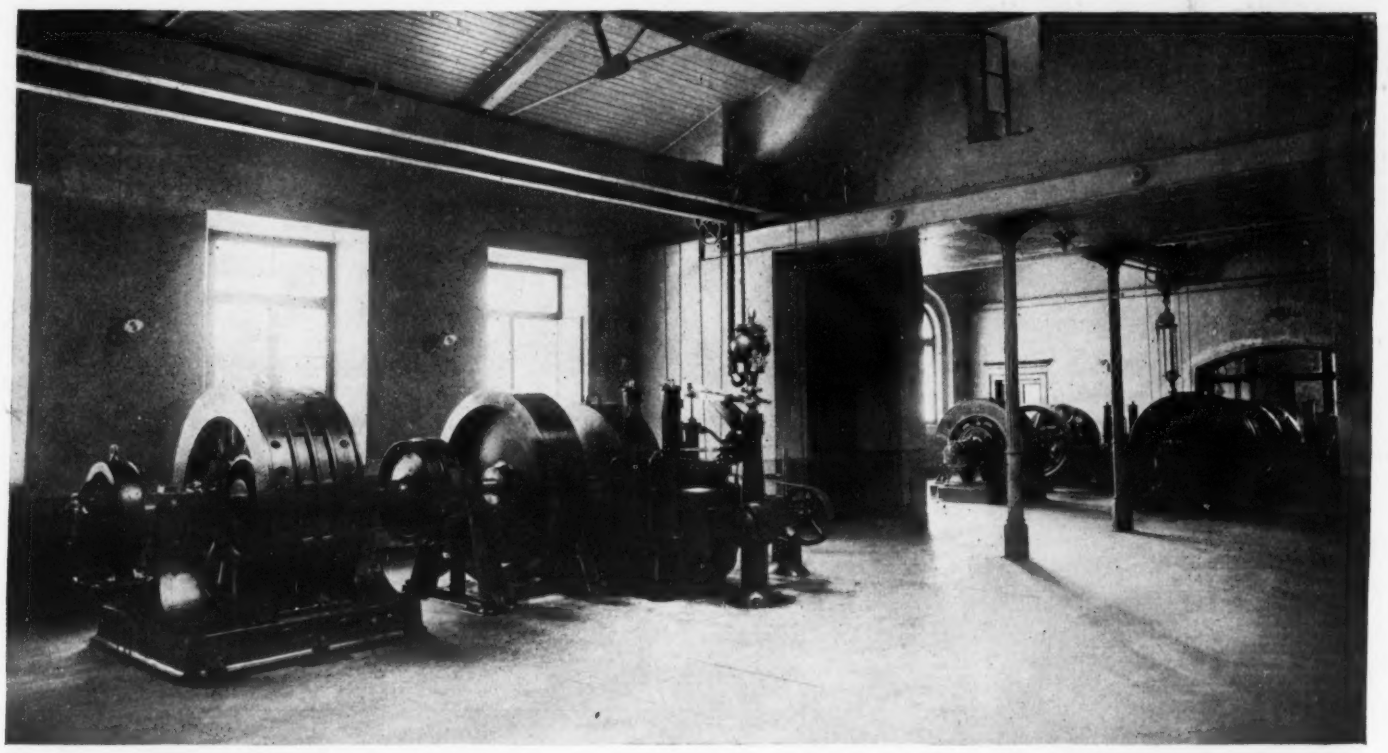


FIG. 1.—VIEW OF INTERIOR OF RIVA STATION.

In the second floor is a room for employees. Each machine room is fitted with a hand-power crane of 5 tons capacity, and the rooms are lighted with incandescent lights. The floors are of substantial parquetry.

Two of the first group of 150-hp turbines are of the Girard type and the third turbine of this group is of the Rusch "spoon-wheel" type. The general arrangement of the three turbines, which make 300 r.p.m., is the same. Each turbine is regulated in two ways—by a hand wheel and by an automatic governor. The hand-wheel regulator through a worm and rack and pinion opens and closes the fly wheel on the shaft between the turbine and dynamo. The three first turbines develop a net efficiency at brake test with full gate of 81.33 per cent and with half gate 80.84 per cent. The 300-hp turbine with full gate shows 82 per cent.

In the portion first erected are three three-phase dynamos of 150 hp capacity each, and in the second a three-phase dynamo of 300 hp. All the dynamos, which are of Oerlikon type, and are connected with their turbines by insulating elastic couplings. The exciter dynamos are coupled direct with the generators.

The diameter between poles of the three first generators is 3 ft.

FIG. 3.—TUNNEL ENTRANCE.

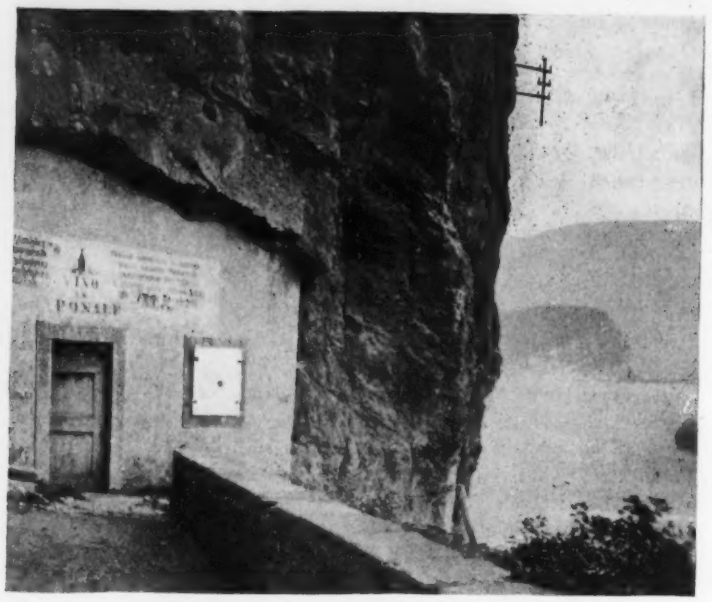


FIG. 5.—WIRES ON CLIFF AT GARDA LAKE.

FIG. 4.—OPEN CANAL.

FIG. 6.—TRANSFORMER HOUSE.

gates. The rods of the automatic governor are connected with a hydraulic relay which acts upon a balance valve, thus regulating accordingly the amount of water admitted. The 300-hp turbine in the addition is of the Rusch type, the water being admitted through phosphor bronze passages. The blades of the turbines are Delta metal and interchangeable. Automatic regulation is accomplished by a balance valve responding to a sensitive centrifugal governor. For the prevention of sudden jars an oil dash pot is connected with rods to the governor. The turbine is also regulated by a hand-wheel regulator, through worm and rack and pinion. For each of the machine units the automatic regulation is supplemented by a

3½ in., and the armature has a diameter of 3 ft. 3 in. They have 18 coils, two with 60 windings and the remainder with 59.5 windings of 1-6 in. wire. The 300-hp generator, also of the Oerlikon type, has an armature diameter of 4 ft. 3 in., and 21 coils which have 42 windings of 3-16-in. wire. The diameter of the revolving field is 4 ft. 2⅝ in. The 14 exciter coils are connected in series and have 130 windings of ¼-in. wire.

The conductors pass in a masonry canal under the floor to the apparatus room, which is entirely cut off from the machine rooms. The switchboard is faced with white marble and is mounted on an iron frame work. It is divided into five panels, four at present being

in use. In addition there is one general instrument panel. On each generator panel is a voltmeter, a four-pole switch, the starting and regulating apparatus, an exciter ammeter, and a phasing lamp. The general instrument panel carries a suspended voltmeter with switch for measuring the voltage of the three phases, and an ammeter for each phase.

In the switch room, the portion which adjoins the machine room and that which contains the four-pole high-tension switch are separated by a special partition of perforated iron. Above the four-

FIG. 7.—CANDELABRA WITH ARC AND INCANDESCENT LAMPS.

pole switch are the measuring transformers with safety fuses, while below rheostats and carbon cut-outs are arranged. On the other side of the aisle are the machine fuses, and on the north side of the room are eight wire fuses. Of these eight fuses, four are constantly under pressure, the remainder being held in reserve, so that in case of a burning out no interruption of service will occur.

The high-tension mains to Riva do not proceed by the most direct route, as that has been utilized for state telegraph wires. The city is reached by a circuitous route over the rough surface of the mountain side and along the cliffs of the Lago di Garda. The mains are carried on triangular iron brackets whose feet are imbedded in the sides of precipices, and where permissible on iron and wood poles, of which, however, few are used. There are three wires and one neutral wire, each of hard drawn copper and ¼-in. diameter, and supported by double bell insulators. The high pressure mains enter at a tower from which an underground iron armored lead-covered cable of four wires passes to the transforming stations of the city. This cable is laid in sand under tile, covered by earth. At the two points where the high tension circuits leaves the city—one to Tarbole and the other to Varone—a tower again brings the mains above ground. A branch of the circuit to Varone leads to St. Giacomo. The length of the high-tension circuit in the city is 0.62 miles, the length to Tarbole is 3.5 miles, to Varone 1.9 miles and the branch to St. Giacomo 0.2 miles. These branches from Riva are supported

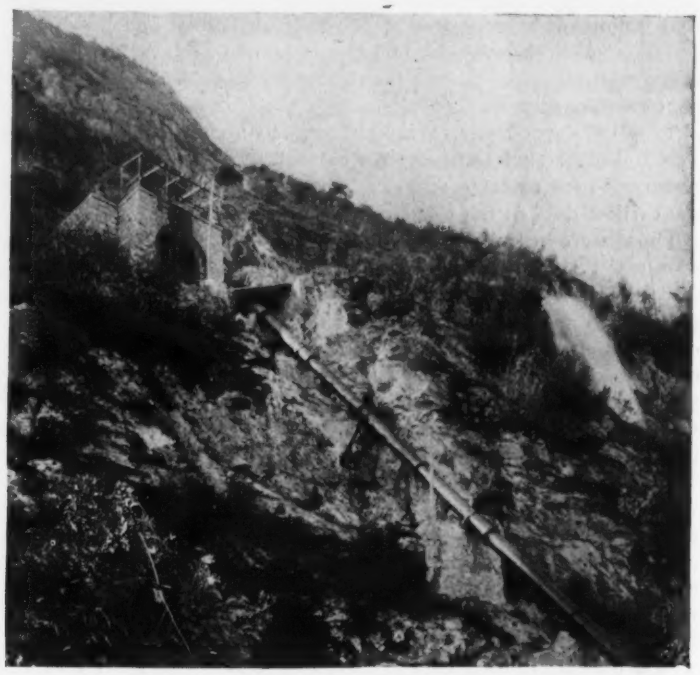


FIG. 8.—PENSTOCK.

on wooden poles and double bell insulators. The poles are 36 feet long and the tops are charred. The mains are fitted with horned lightning arresters.

The transformers are in fire-proof rooms, and each has a four-pole switch for the high-tension, and another one for low-tension, and one each in Tarbole and St. Giacomo. Low-tension wires are carried on wooden poles and brackets on the sides of houses, the wires used being from 3-16 in. to ⅜-in. diameter.

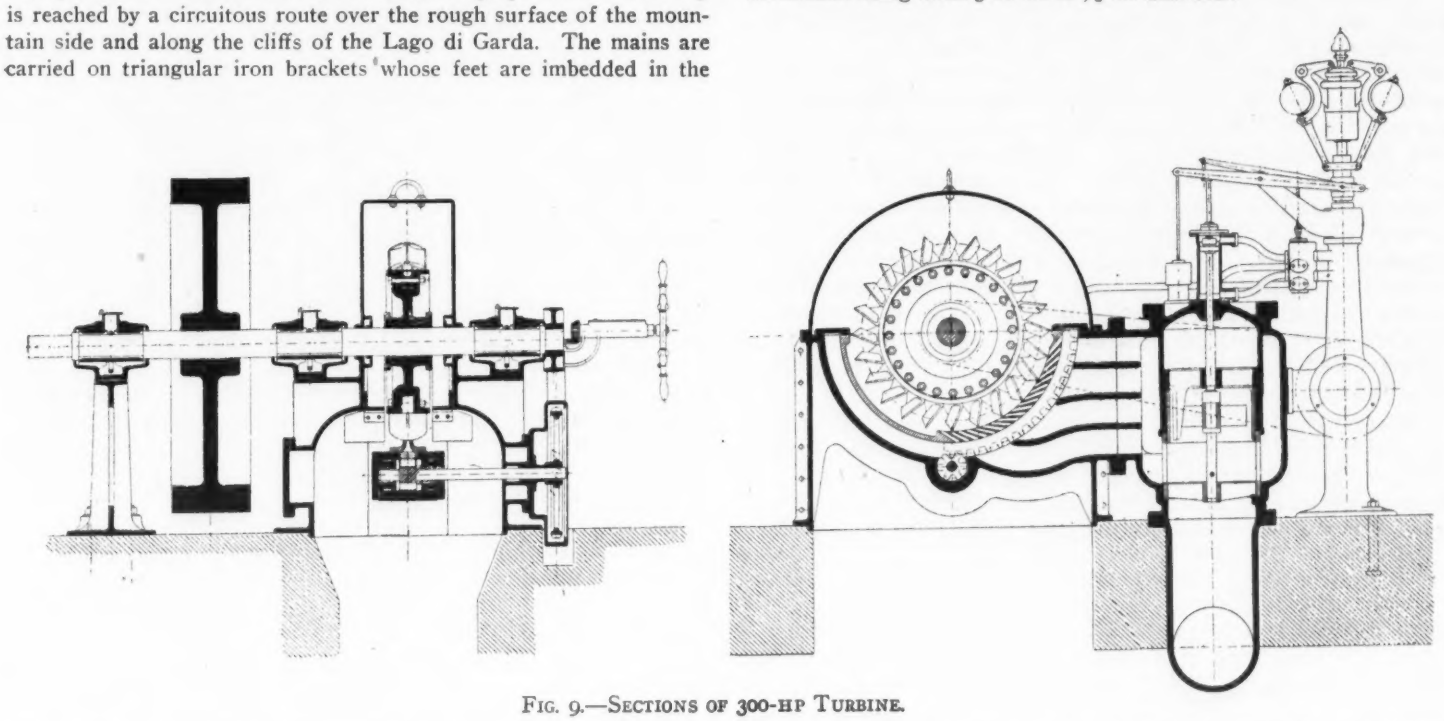


FIG. 9.—SECTIONS OF 300-HP TURBINE.

Arc lamps of 800 candle power swing from graceful candelabra or from suspension wires. They are 20 ft. above the street. The exposed incandescent lamps are also mounted on candelabra, on arms or on masts and are of 32 candle power. They are connected between one phase and the neutral wire and are in a 110-volt circuit. The power plant is in constant operation day and night except from noon to two o'clock on Sunday.

The Gas That Failed.

BY ALTON D. ADAMS.

THE fact that this year—1904—marks the twenty-fifth anniversary of the commercial introduction of the incandescent lamp would in itself render interesting a review of the growth of that illuminant as compared with gas. But special and peculiar interest is given to such a comparison by the remarkable fact just brought out by the United States Census office bulletin on central stations that such stations alone, regardless of isolated plants, have already overlapped gas in investment, labor employed, gross earnings and other vital features. An extraordinary chapter of industrial history is here revealed and one's thoughts go back involuntarily to the earliest days of the electric lighting art.

Those were years of conflict in the lighting field. Gas companies soon saw their incomes from street lamps dwindling, and their commercial business in danger. Rays of electric lamps had caught the popular eye and fancy. The illuminant that simulates daylight, requires no matches and operates without a flame was in rapidly growing demand. Two particular groups of persons stood ready to turn this situation to their own advantage. These were the purveyors of oil and the exploiters of patent gas processes. The hopes, the aims and the future gains of these persons were summed up in "water gas." All this was in the decade of 1880 to 1890.

Even at the beginning of this period water gas was not a new product. Before Brush gave the electric arc commercial importance, before Edison and his contemporary workers had solved the problem of multiple distribution with incandescents, Lowe and others had reduced the water-gas process to a high degree of perfection. Men with oil and patent rights had for some years infested the offices of gas companies with very moderate success. The makers of coal gas had heard the orators of "water," had considered the high cost of the "inventions," compared the uncertain price and limited supply of oil with the steady market of gas coal, had consulted their satisfactory net profits, smiled and continued as before.

Shortly after the general introduction of the electric light, the gas situation changed. The great field of heating by gas was then almost unknown. Gas managers saw the lighting business, almost their sole reliance, rapidly turning to electric stations, and were troubled. Then the hour of the water-gas man was struck. He became the Moses of the hour. Cheaper gas was wanted and the patented apparatus could supply it; greater candle-power was wanted, and oil would give it, so it was claimed. Competition must be met, so gas managers thought, and water gas was extensively introduced. In this movement of the gas interests Massachusetts hung back. The public and the legislators of that State recognized the deadly qualities of water gas, and its distribution was early interdicted by law. During the decade mentioned, the gas interests made repeated appeals to the Legislature for the privilege to freely make and sell water gas. For a series of years these applications were in vain, but at last the arguments of patent owners and oil venders overcame the real or assumed scruples of legislators, and a bill removing the restrictions on the distribution and sale of water gas was approved April 30, 1890. Since that date the fears as to water gas have proved to be only too well founded, for the deadly stuff has ended the lives of more than 300 victims in Boston alone.

However, the industrial side of the question is all that can be considered here. The great argument for water gas was that it would serve to check the rapid advance of electric lighting, by means of lower prices and higher candle-powers than had prevailed with coal gas. It is the purpose here to test this argument by the hard facts of experience. This may be done in two ways. First, by comparing the growth of the gas and the electric lighting industries since the removal of the restrictions on water gas. Second, by noting the ratio which water gas has held to the total volume sold. Boston has been the proving ground for much the greatest water-gas experiment in Massachusetts, and figures from this field are thus selected in the present case. No better measure of the growth of the gas industry could be desired than the volumes of gas annually sold to consumers, as this avoids any uncertainty due to changes in price. Figures are accordingly given for the cubic feet of gas sold to consumers during each year from 1890 to 1901, in all parts of Boston, except the suburbs of East Boston, Jamaica Plain and West Roxbury. In these suburbs no water gas has ever been sold. Unfortunately, it is not possible to present figures showing the total sales of electrical energy in the Boston territory during this series of years. There are no census figures, unfortunately, to refer to, so far back. The growth of electrical supply may be approximately measured, however, by the number of tons of coal burned each year in electric stations. The number of tons of coal burned yearly by the three largest electrical supply systems in Boston, which generate most of the energy sold in the city, are, therefore, given. It should be borne in mind, however, that while the cubic feet of gas sold form an accurate measure of the expansion of that industry, the same cannot be said of the weight of coal burned in electrical supply, because the delivered energy has increased faster in amount than the fuel consumed. Consequently, the showing for the electrical industry is less favorable than are the real facts. Delivered energy has increased in amount faster than the coal consumed because electric stations have been much improved in efficiency since 1890. For the fiscal year ending on June 30, 1890, the relative amount of water gas was small, because no gas might then be distributed that contained more than 10 per cent. of carbonic oxide. Notwithstanding the removal of restrictions on water gas in 1890, the total volume of combined coal and water gas sold did not go up immediately, but on the contrary declined a little. During each of the four following years the figures for total sales of all gas ranged below those of 1890, and in 1894 the volume sold was 93 per cent. of that in the earlier year. This falling off in the total sales of combined coal and water gas took place in spite of the fact that water gas, of which only 193,000,000 cu. ft. were sold in 1890, reached a volume of 1,378,000,000 ft. in 1894. Meantime the coal consumed by the electric stations increased from 24,589 tons in 1890 to 50,374 tons in 1894, touching 53,675 tons in the "expansion" year that ended June 30, 1893. In other words, during four years after the legal restriction on water gas was removed, the total sales of both coal and water gas declined a little, but the coal consumption at electric stations more than doubled. For the fiscal year of 1894 water gas rose to 90 per cent. of the total sales in the Boston territory, without increasing the combined output of coal and water gas, or checking the rapid extension of electrical supply. In the following year the gas situation changed. What water gas had not done and could not do, boost the total gas output, was accomplished by other means. Under date of June 19, 1894, one of the large Boston gas companies issued a circular offering a $17 gas range free, connected in position, to any of its customers, this range to become the absolute property of the customer after the exclusive use during one year of the company's gas. This move naturally evoked competitive measures on the part of the other gas companies. Though these gifts of gas stoves were prompted by material competition, they did what could have been done in no other way, aside from a large reduction in prices; that is, they caused a rapid increase in the volume of gas sold. Under the stimulus of free stoves the volume of annual gas sales rose from 1,524,000,000 ft. in 1894 to 2,271,000,000 ft. for 1896. There need be little uncertainty as to the use to which this increased volume of gas was put. In 1894 the number of gas stoves in use at Boston was so small that the gas commissioners did not record it in their report. On June 30, 1895, the number of these stoves had reached 23,881, and by the like date of 1896 the number was 49,610. In view of these figures for stoves and of the previous uniformity of gas sales, it is clear that the increased volumes of gas during these two years were mainly devoted to heating. While the gas companies were enjoying the expensive luxury of business obtained by the payment of "chromo" premiums, the electric lighting industry was slowly expanding on a more conservative basis. From the middle of 1894 to the middle of 1896, the period of two fiscal years, the total volume of gas sold increased 49 per cent., and the weight of coal burned by electric stations 17 per cent. By the end of June, 1896, the gas interests had grown tired of giving away stoves and the practice was soon thereafter discontinued. When free stoves could no longer be had, the expansion of gas sales came to an abrupt end. During the three years following 1896 the total volume of annual sales of gas established in that year was hardly maintained. Compared with the 2,271,000,000 ft. of 1896, the volume for 1899 was 2,269,000,000 ft. Water gas formed much the greater part of the total output from 1894 to 1899, but it was powerless to expand the volume of gas sold, as shown by the stationary condition of the industry during the three later years of this period. If water gas could not bring about larger total sales of gas or even hold what had been gained by the gifts of stoves, neither could it check the onward swing of electric lighting. From 1896 to 1899 the consumption of coal at electric stations in-

creased 28,162 tons, or 50 per cent. of the weight burned in the earlier year, while the gas industry was vainly trying to maintain its record. This year of 1899 is a good point from which to look back over the record of the gas and electric industries since 1890.

Volumes of gas sold in the Boston territory and the volumes of water gas:

Year.	Cubic feet, total.	Cubic feet water gas.	Percentage of total. coal.	water.
1890	1,627,336,951	193,352,779	88	12
1891	1,507,756,807	561,891,635	63	37
1892	1,527,604,172	902,625,048	51	59
1893	1,594,531,897	1,170,658,199	27	73
1894	1,524,864,297	1,378,106,905	10	90
1895	1,869,378,991	1,815,289,524	3	97
1896	2,271,327,822	2,077,223,942	9	91
1897	2,288,566,862	2,080,759,737	9	91
1898	2,258,640,970	2,184,781,672	3	97
1899	2,269,367,070	2,194,963,361	4	96
1900	2,397,835,462	1,804,888,902	25	75
1901	2,553,229,570	955,723,749	63	37
1902	2,700,792,329	1,200,163,970	56	44

During the nine years, gas has had two of rapid increase and seven years of nearly stationary output. Compared with 1890 the fiscal year of 1899 shows an increase of total gas sales, amounting to 39 per cent. In the same nine years electric lighting has had two years of nearly stationary output and seven years of rapid increase. While the volume of gas sold gained 39 per cent., the weight of coal burned at electric stations went up 242 per cent. The rate of increase of annual fuel consumption in the electric plants has thus been 6.2 times as great as that in the volume of gas yearly sold. Meantime the aggregation of patent gas processes and oil accomplished a purpose, but did not check the electric industry.

Tons of coal burned by the Edison, Boston and Suburban electric lighting systems of Boston:

Year.	Tons.	Year.	Tons.
1890	24,589	1897	60,566
1891	31,645	1898	70,578
1892	47,683	1899	83,872
1893	53,675	1900	80,489
1894	50,374	1901	80,058
1895	51,162	1902	65,131
1896	55,710		

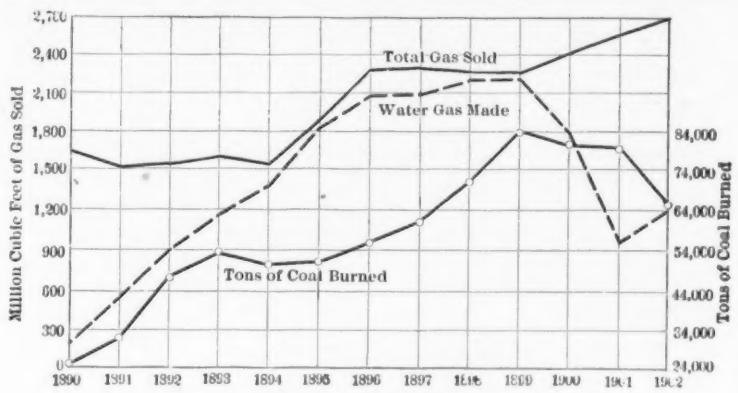
Water gas, starting with only 12 per cent. of the total volume of gas sold in 1890, increased rapidly to 90 per cent. of the entire volume in 1894. From the fiscal year last named to that of 1899 inclusive the percentage of the water gas made to the total product sold was never below 90, and in two instances stood at 97.

During these five years water gas substantially displaced coal gas in the local field, but not in one of them did its brilliant illuminating power or alleged low cost of manufacture check the expansion of electrical supply. In only two years out of the five was the total volume of gas sales materially raised, and then the increase was due to gifts of gas stoves. These stoves appear to have raised the annual consumption of gas about 750,000,000 ft., which would leave the volume of gas yearly burned for illumination just about stationary from 1890 to 1899, inclusive. Now a stationary consumption of gas for illumination in the face of an increasing population means an actual decline in the use of gas per capita for that purpose. It is highly probable that this is just the situation which the Boston gas interests have to face. For the decade from 1890 to 1900 the increase of population at Boston was 25 per cent. If the fifty odd thousand gas stoves now used in the city are doing much baking, it seems hardly probable that illumination by gas has kept pace with the population.

Consideration of the years 1900 and 1901 has been reserved until this point, because they present several new and interesting conditions in the gas and electric field. For the first time during the eleven years under consideration, gas sales show a substantial gain without the aid of an artificial stimulus, like gifts of gas stoves. This gain in the volume of gas sold for 1901 was 12 per cent. over the volume for 1899. Strange to tell, however, while the total volume of gas was going up, that of water gas, the cheap, brilliant illuminator, went rapidly down. From 96 per cent. of the total volume of gas sold in 1899, water gas fell to only 37 per cent. of the like volume for 1901.

This is not the time to explain or guess at the inside working of gas deals. A consideration of the exact causes that lowered the percentage of water gas from 1899 to 1901 would be as much out of place here as would the causes that raised it from 12 in 1890 to 97 in 1895. Of prime interest from the electrical point of view is the fact that a gas, which was introduced with much noise about what it would do to electric lighting, has failed to maintain the advantages formerly gained by coal gas, and failed even in the struggle with coal gas to hold the Boston field against the latter. It is the irony of fate that water gas, from which so much was expected, should be in a rapid decline during the only two years since its general introduction when the volume of gas used for illumination shows any material gain. A glance at the figures and curve for coal burned at electric stations from 1899 to 1901 seems primarily to indicate that at last the long and rapid expansion of electrical supply has been checked. The tons of coal burned, which stood at 83,872 in 1899, were down to 80,058 in 1901. Instead, however, of a failing prosperity, electric lighting in Boston has enjoyed the double advantage of increasing business with a declining fuel consumption during the two years in question. The higher economy of fuel has been effected by marked changes in electric generating stations. To a large extent the generating equipment of 1899 was that of 1890. Comparatively small, simple engines, working non-condensing, and many belted dynamos, did a large part of the work of electrical supply in the Boston field during the year ending June 30, 1899. Under these conditions a rather large consumption of coal per unit of energy output was inevitable.

During the fiscal year of 1899 the Boston Electric and the Edison systems had in use 81 engines and 215 dynamos. In the year of 1901 nearly all the work of these systems was done with less than



GAS AND COAL CURVES.

24 engines and 85 dynamos. These engines all worked condensing and both the engines and dynamos had average capacities much beyond those of the earlier year. A reduction in the amount of coal burned by the electric stations during 1901 from the weight consumed in 1899 was thus due to increased economy of operation, and not to failing business. Further and conclusive proof of this fact is found in the figures for incomes from sales of electrical energy in the Boston field during the years under consideration. For the fiscal year of 1899, the combined incomes of the Boston Electric, Edison and Suburban Companies from the sale of electric light and power amounted to $1,900,052.82, and the corresponding sum for 1901 was $2,348,207.14, an increase of 23 per cent. over the former year. This increase is almost double that of 12 per cent. recorded for the rise in the volume of gas sales between the same years. While electrical supply was making this latest gain, completing two decades of unparalleled expansion, there was a shrinkage in sales amounting to 57 per cent. in the volume of the gas that failed.

Russian Telephones.

The Russian and German post-offices have arranged to construct a telephone line between Berlin and St. Petersburg, via Edtykuhneu, on the German frontier, and Wilna, in Russia. The construction will begin in 1904.

Long Swiss Road.

Two engineers of Zurich, Switzerland, Messrs. Grote and Westermann, have recently applied for a concession to build an electric railroad in the Bernina Pass, Canton of Graubünden. This new road will run from St. Moritz to Pontresina, thence over the Bernina Pass via Poschiavinatal, to Tirano, where it will connect with the Veltlin electric road, a branch of the Adriatic Railroad Company. The new road will have a length of about 40 miles.

Telephone Spring Jack Decision.

We are indebted to Mr. F. F. Sapp, of the North Electric Company, Cleveland, for the following clear digest of the recent decision in regard to telephonic jack springs noted last week:

Some two years ago the Western Electric Company entered suit against the North Electric Company, at Cleveland, upon the following patents, covering the construction of spring jack switches: 357,538, Charles E. Scribner, February 8, 1887; 488,033, Scribner & Warner, December 13, 1892, and 552,729, Charles E. Scribner, January 17, 1896. The second patent, that to Scribner & Warner, is one which has long been considered to be one of controlling importance in the telephone field, and the well-known features of the type of spring jack manufactured by the North Company were confidently asserted by the Western Electric Company to be plainly an infringement on the sweeping claims of this patent. These claims have frequently been sought to be evaded or avoided by manufacturers of telephone apparatus, but relating as they do to the employment of long and short springs for controlling the two limbs of a telephone circuit, the evasions, to say the least, have been doubtful.

The other patents relate more particularly to features of construction of the strip of jacks. The first, the "early Scribner patent," discloses a spring jack switch fully assembled, and insertible in, and removable as a unit from, the comb-like strip or frame of rubber, which is bored and slotted to receive within its body, a number of such jacks. The parts of this jack, corresponding exactly to similar parts of still earlier spring jacks, are punched from sheet metal, assembled in parallel planes, and secured together with rubber insulators, by means of a transverse screw and pin, to form a complete jack, which is fastened at its rear by "a single screw" passing through a laterally extending ear or lug into the edge of the rubber frame or strip.

By reason of this arrangement, the patent states: "On removing the screw of any jack it is evident that the jack may be removed, and all parts of its parts thus made accessible for adjustment or repairs."

Obviously, the thin metal punchings described are lacking in the strength necessary to withstand ordinary service, but the patent further says: "Being, however, connected together and supported by the rubber frame, as before described, they will be sufficiently rigid to be durable and effective for the purposes for which they were designed."

Four claims, 1, 2, 3 and 5, were declared upon. The first, second and last, relating to these individual jacks in combination with the slotted rubber mounting frame or comb-like support formed to contain said jacks, and the third claiming the completely assembled jack, but separate and apart from the frame. The principal reference relied upon by the defendants was the well-known type of spring jack shown in the expired patent to Richard V. Freeman, No. 309,218, dated December 16, 1884, under which suit was brought some years ago by the Bell interests at Detroit. A number of other references were offered in evidence relating to certain features of the Scribner construction. In the Scribner & Warner patent another type of spring jack is shown, designed for specialized use in a single portion or section of a multiple switchboard. It has two springs of different lengths, adapted to engage separate corresponding contact parts upon a switching plug, provided for insertion in the jack. The two springs have normal inner contacts, from which they are separated by inserting the plug.

In this patent in suit, a tubular test piece is permanently connected with the longer of the two line springs in the jack, as stated in the patent: "In order to make the contact between the sleeve of the loop plug and one of the springs more certain and to adapt the plug for use in multiple switchboard systems" while the end or tip-contact, of the plug is of smaller diameter than the sleeve, as in prior patents, in order that the longer spring "may be so adjusted as not to form contact with said tip," although no advantage or function is mentioned as being attained thereby.

The first and third claims were relied upon by complainant; the first setting forth, not in a spring jack but very broadly, in "a circuit-changing device," an admittedly old combination of elements, as is shown by the file wrapper, including two springs, their normal contact pieces, and the tube or guide, in combination with this old two-contact plug, having its tip smaller than the sleeve; a feature previously adopted to prevent its making contact with and closing circuit through the frame of the early individual jacks. In the third claim is set forth the combination with two springs, here specified as being of different lengths, of the "guide in front of said springs," and a plug having two terminals, one upon the tip, whose size is not specified, and the other upon the sleeve. Both claims are somewhat amplified by the recital of functions accomplished by the elements thereof, but without in any way confining the alleged invention to spring jacks, or any other specific form of circuit-changing device. Two patents of Charles E. Scribner, 383,013 and 427,123, were employed to show the strong probability that no joint inventorship actually existed with respect to the features broadly claimed in this patent in suit, while that of Trayer & Kugler, No. 377,788, of February 14, 1888, clearly discloses the use of long and short springs in an earlier spring jack switch.

The last patent in suit, Scribner, 552,729, also describes a specialized form of spring jack adapted for use in a single portion of the multiple switchboard, and was designed in part to accomplish much the same purpose as was the device of the last patent in suit considered.

The patentee says that he has provided a spring jack "whose switch contacts shall be accessible for testing to determine the insulation and continuity of the circuit wires." This he accomplishes by the use of a rubber mounting plate of distinctive character, recessed to contain the inserted spring jacks; each of the receiving grooves provided therein being forwardly expanded or enlarged to afford ample space for the extremities of the four springs of the inserted jack. Rubber insulating tongues or washers, as in the early Scribner patent, electrically separate the several springs; all of said parts being laterally bored to receive two insulating pins for securing the jack parts together, prior to individually mounting the jacks in the grooved plate, by means of two side screws inserted rearwardly in the rubber frame, and bearing upon the rear of the said jack parts. The patent further states that each jack "essentially comprises," among other parts, two short thimbles, *d* and *e*, forming "the usual 'local' contact pieces which are connected with the annunciator for the purpose of restoring it and for testing purposes."

Claims 2 and 4, declared upon, relate to the grooved strip or plate of insulating material, with jacks comprising, respectively, the line springs, and the line and inner contact springs, separated by interposed tongues of insulation, inserted on edge in the recesses or grooves; both of said claims omitting, however, all reference to either of the two thimbles; one being necessary in a jack for multiple switchboards for testing purposes.

Claim 8 specifies simply a partial spring jack, comprising the duplicated line and contact springs, together with their interposed rubbed tongues, and the connecting transverse insulating pin extending through each of the parts.

Against this patent, among others, was cited the one to Scribner & Patterson, No. 489,571, showing substantially the frame or strip for mounting springs flatwise therein, while patent No. 458,258, granted August 25, 1901, to the well-known French inventor, L. A. Berthon, sets forth a strip of spring jack switches having characteristics very closely approaching those set forth in the claims declared upon.

At the hearing of this suit at Cleveland in November last, the complainant found it expedient to dismiss as to claims 1 and 2 of the early Scribner patent, and claim 8 of the last patent in suit. Judge Francis J. Wing, having had the case under advisement since then, filed an opinion December 21 dismissing the bill of complaint at the cost of the Western Electric Company, thus scoring a victory for the North Electric Company and for the independent interests upon three separate patents previously considered of prime importance.

New York Traction.

The managers of the Metropolitan, or Interurban Street Railway interests of New York City, have recently intimated their desire to compete for the building of further subway traction systems on the Island of Manhattan. President Belmont, of the Interborough Underground and Manhattan Elevated, intimates that a transfer arrangement covering all this vast travel might be preferable. The Metropolitan will change from horse to electricity some 40 miles of track during 1904.

Methods of Signaling and Operating in Telephone Exchanges.—III.

BY KEMPSTER B. MILLER AND CHARLES S. WINSTON.

WHEN a subscriber calls for a private branch exchange, the connection is established in the reverse order from that just described, the main office operator ringing down the drop at the private branch end of the trunk by the same operation that she would use in calling a regular subscriber. The private branch operator then listens in on the circuit, and obtains from the calling subscriber the particular branch exchange connection he desires.

The matter of supervising a private branch exchange connection has been the subject of much discussion and final disagreement.

There can be no disagreement as to the proper supervisory signal of the regular main exchange subscriber, for when connected with a subscriber in a private branch exchange he will always have the supervisory signal of the plug connected with his line under his control during a connection, no matter what system is used. The only point to be decided then in regard to the supervisory arrangements is, how shall the branch exchange subscriber clear out or re-signal the office?

On considering this point we find that three different methods have their advocates, and each has been put into commercial use to a considerable extent.

The first of these methods is to place in the control of the private branch subscriber during a connection, the regular cord circuit supervisory signal at the main office only, so that this lamp will light at the main office when the subscriber hangs up his receiver, in exactly the same manner as if he were on a regular subscriber's line entering the main office direct. Upon both subscribers hanging up their receivers the main office operator would pull down the connection, and in doing so the removal of the plug from the private branch exchange trunk jack would light the disconnect lamp at the private branch exchange, after which the private branch operator would pull down the connection.

From the standpoint of clean operating at the main board, this scheme is perhaps best of all. It is found, however, that this arrangement is not desirable from the standpoint of the private branch subscriber, and also has its disadvantages in regard to the city subscribers who desire connection with the private branch exchange. As illustrative of this point, it may be said that a main office subscriber will often call up a certain member of a business firm through its private branch exchange; on stating his business this person, so called, will at once recognize that the business may be best transacted in another department, whereupon, instead of being able to signal the branch exchange operator direct by moving his hook up and down, he is obliged to tell the person who desires to transact the business to call up another line in the private branch exchange. This necessitates the calling party beginning all over again at the main office, and securing the connection perhaps over another trunk line.

This fault is eliminated in the second of the three methods in which the private branch exchange subscriber has within his control during a connection, a lamp at the private branch board only, the action of his hook causing no effect whatever at the main office. Under this condition a disconnection is effected when both subscribers hang up, by the private branch exchange operator first pulling down the trunk connection in response to the lighting of the lamp under control of the private branch subscriber, thus lighting the supervisory lamp at the main office. The main office subscriber having also hung up, the subscriber's operator at the main office sees both lamps lighted and pulls down the connection. It will be seen that the operation at the main office is thus rendered in nowise special, the subscriber's operator receiving both supervisory signals in exactly the same manner as if two local lines had been connected, the only difference being that instead of both supervisory lamps being operated directly by the movement of the subscriber's hooks, one of them is operated by the action of the private branch exchange operator in pulling down the connection.

With this arrangement a private branch exchange subscriber who has been called and who desires to have the calling party put in connection with another person in the private branch exchange, has only to move his hook up and down to signal his own private branch operator, whereupon she will complete the connection with the calling subscriber and whatever other private branch exchange line is designated. Another advantage of this second method of supervisory signaling is that if the branch exchange subscriber desires to signal for another connection, after the close of a conversation, he can at once secure the attention of the private branch operator and have her attend to it for him, hanging up his own receiver until she secures the party wanted. This system has the disadvantage of requiring a somewhat more complex cord and trunk circuit at the private branch exchange.

In the third method, used to a large extent by both Bell and Independent companies, the private branch subscriber has within his control the supervisory signal at *both* the private branch exchange and the main office, thus when he hangs up his receiver both lamps light, thus sending in a disconnet signal directly to the main office and to the private branch office simultaneously. Under this arrangement some confusion is liable to occur by both operators coming in on a circuit at the same time in response, for instance, to the private branch subscriber's action of moving his hook up and down. In doing so he usually desires the attention of the private branch operator, rather than of the main office operator, and the main office operator may notice this at once and cut her telephone out of the circuit. If the private branch subscriber desires to have the party with whom he is connected, connected with another line in the private branch exchange the main office operator is not likely to pull down the connection in response to the movement of his hook, because the main office subscriber will not have hung up his receiver, as he will be waiting for the new connection.

This method of having the signals at both the main office and the private branch office under the control of the private branch subscriber, has an advantage in point of simplicity and first cost, as the circuits are very simple, and it has a further advantage in that it tends to clear the main office cord circuits quicker after a connection than in the second method described.

All things considered, from an operating standpoint only, it is probable that the second method, where the private branch subscriber controls a supervisory lamp at the branch exchange only, is best. It is not, however, quite so simple as the third method, and therefore the item of first cost and maintenance enters as an offset.

There appears to be no definite standard for the operation of private branch exchange systems established by the various Bell companies, as, apparently, the different operating companies have their own ideas which the manufacturing company follows. There seems, however, to be a tendency among these companies to adopt the method of operation in which the private branch subscriber's supervisory signal goes to the private branch operator alone, the disconnect signal at the main office being given when the private branch operator pulls down the connection. However, the system which now appears to be standard for the Chicago Telephone Company, employs the third method, having the supervisory signals of the private branch subscriber go simultaneously to the main office and to the private branch operator.

In this latter system the arrangement of the signals is somewhat ununusual and is of interest. The private branch exchange trunks terminate as usual in the main switchboard in the same manner as anv subscriber's line. At the private branch exchange they terminate in a jack and lamp, the lamp being under the control of a locking relay, which is operated by the calling generator from the main exchange, but which, when operated, locks by means of an additional coil, energized by current from the local common battery at the private branch exchange. In operation, therefore, the main exchange calls the private branch exchange by ringing on the trunk line in just the same manner as if the call was being sent on the regular city line.

Instead of having supervisory lamps associated with each plug of a pair, there are no separate supervisory lamps on the private branch exchange board, but in lieu thereof the calling lamp of each line is made to serve, it being, after a connection is made, put under the control of the subscriber on its line. Thus the lamp serving as a line lamp when a subscriber takes his receiver from its hook, goes out when the operator plugs in. However, the act of plugging in by the operator changes the circuit of the lamp so that it will again light when the subscriber hangs up, to again be put out when the operator pulls down the connection. This double use of the line lamps is perfectly permissible in small boards because the lamp is always adjacent to a plug when the connection is made. Its lighting, therefore, leaves no doubt in the mind of the operator as to which plug and cord requires her attention. This would not, however, be possible in a multiple board.

The method of supplying current for talking and signaling purposes to private branch switchboards has been the subject of much

thought, and the usual practice is now, unless the private branch board is very close to the central office, to install a separate storage battery at the private branch exchange, and to charge this over the trunk lines when not in use.

In the system of the Chicago Telephone Company, just described, this battery is normally fed to the cord circuits on the private branch board through retardation coils in the usual manner, so as to serve when two private branch subscribers are talking together. If, however, a private branch subscriber is connected through a trunk to the central office he draws his talking current directly from the main office battery over the trunk lines, a locking key being provided for each circuit by which the operator may cut off the battery from the pair of cords when so used.

In some of the private branch exchange systems installed by the Kellogg Company the private branch operator is provided with the regular pairs of cords and plugs for making all connections, each cord and plug being provided with a supervisory signal the same as in larger common battery exchanges. The trunk line terminates on a private branch board in a jack and an ordinary ring-down drop, this drop being manually restored by the operator in response to a ring from the central office; otherwise the operation of the system is the same as that of the Chicago Telephone Company, except that the act of cutting off the battery from any cord circuit is accomplished automatically rather than manually. This battery is normally connected with each pair of cords and plugs; but as soon as the operator inserts the plug in the trunk jack a relay is operated which cuts off the battery from the cord connected with the trunk jack, thus allowing the signal connected with that cord to be operated by battery from the main office.

In most of the Kellogg systems, notably those of the Home Telephone Company, of Los Angeles, the third method of conveying the clearing-out signals is used, where both the main office and the private branch exchange operator receive the private branch exchange subscriber's clearing out signal simultaneously. In these systems the trunk line ends in a plug and a drop, the operator connecting a trunk to any private branch line by inserting the plug of the trunk into the jack of the private branch line.

The trunk line is in this case provided at the private branch end with a supervisory signal in the form of a lamp, this lamp, together with the supervisory lamp of the cord used at the central office in connecting with the other end of the trunk line being under the control of the private branch subscriber during a connection. We believe that this plan of terminating the private branch end of the trunk lines in plugs is also largely used by the various Bell companies. It, of course, necessitates a change of cords by the private branch operator when a trunk connection is to be made, as she usually answers a local call by inserting one of the plugs of a pair of local cords into the line jack.

As between the ring-down drop, and the lamp as means for receiving trunk calls at the private branch board, it is difficult to see why the latter is desirable. As a rule, the private branch exchange operator has very little to do, and on account of the reasons already mentioned, simplicity in her apparatus is very desirable. For this reason it appears that if an ordinary ring-down drop offers any advantages in simplicity over the locking relay and lamp, or if the same is true of the termination of a trunk in a plug rather than in a jack, it is advantageous to have the private branch operator give a somewhat less artistic signal or make a few extra movements for the sake of this simplicity.

Sometimes in private branch exchange work it becomes desirable to use party lines, and to afford means for the different parties on a line to call each other without calling the branch office, or to call the branch office without calling the other stations on the line. This is often desirable in large institutions extending over considerable territory. It affords the advantages of a private line between various departments in combination with that of city service. In giving such service as this in connection with the modern exchange system, it is customary, while supplying all current for talking purposes from a common battery, to resort to magneto calling between the stations of a line. Thus each station is provided with the usual common battery talking and call-receiving apparatus, and with a magneto generator adapted to be bridged across the line when operated. In order to prevent the line signal at the private branch exchange being operated by the current from the magneto generator, a differential line relay is used, having one winding in each limb of the line. Any current sent over the metallic circuit of a line will therefore not operate this signal, and thus any subscriber on the line is enabled to call any other, the same as on any bridging-bell party line. In order to enable any subscriber to call the central office, a push-button key is provided which grounds the live side of the line, thus causing the operation of the line relay and lighting the line signal.

It is sometimes necessary in very large institutions to provide two private branch exchange switchboards, as where the same firm has different buildings in different parts of the city. Where this is the case it is better to provide trunk lines directly extending between the two private branch exchange offices, in order to prevent the necessity of having calls for connection between subscribers in the two different exchanges being handled through one or more of the city offices. Where the two private branch exchanges are very large it is probably better to use one-way trunks, the same as between two offices in a city exchange. Where, however, the exchanges are comparatively small and the number of trunk lines few, it is the best practice to provide two-way trunks in order that either trunk may be used in either direction. Where such is the case the usual arrangement is to terminate each trunk line at each private branch board in a jack and a lamp. When the operator at one end plugs into the jack of the trunk line two lamps, one at each end, light simultaneously. Both lamps are extinguished when the operator at the other end plugs in in answer to the call. The first operator is therefore made aware of the response or non-response of the operator at the other end of the line. As soon as either operator pulls down the connection at one end both lamps light and both are extinguished when the other operator pulls down the connection. It usually requires quite a complicated circuit to produce this result without using more than two wires in the trunk line; but as trunk lines in large cities are expensive the complication is warranted when the lines are of considerable length.

A type of private branch exchange service new, so far as the writers are concerned, has recently come into use to a limited extent on the Pacific coast, or, more specifically, in both Bell and Independent exchanges at Los Angeles. The system used by the Home Telephone Company at Los Angeles (Independent) is, it is thought, the more complete of the two, and is worthy of description. It combines some of the features of the ordinary private branch exchange with those of the ordinary intercommunicating telephone system, wherein each subscriber is enabled to make his own connection without the intervention of an operator. A line is therefore provided for each private branch subscriber, terminating at each station in a jack. Each subscriber's telephone set consists of the ordinary common battery talking apparatus terminating in a plug, and also in a push-button for calling and a battery bell for receiving calls.

Each subscriber may, therefore, call any other subscriber in the private branch exchange by simply plugging into the jack belonging to the line of that subscriber, and pressing the button. So far the system is the same as the ordinary intercommunicating or house system. In addition to the local subscriber's line, however, each trunk line to the main exchange is extended through all of the stations in the private branch exchange terminating at each station, as before, in a jack. Each of these trunk lines also terminates in two jacks and a magneto bell on an attendant's desk, the attendant being provided with a telephone set similar to that of the subscriber, and also with a separate closed circuit plug for the purpose of holding the line. If any subscriber desires a connection with the city exchange he has only to insert the plug of his telephone set into the jack of one of the trunk lines. If the line is busy he learns the fact by hearing the conversation in progress, and in such case is expected to withdraw his plug. If, however, the line is not busy the operator at the main office responds in the usual manner, as the line lamp belonging to the trunk line is lighted. The subscriber calling then gives his order directly to the main office operator, and the connection is completed in the usual manner. An incoming call from the main exchange rings the bell on the trunk line at the attendant's desk. The attendant plugs into one of the jacks of that line and answers, inquiring what party is wanted. Learning this, she usually plugs into the other jack of the trunk line with the holding plug, which keeps the circuit of the trunk line closed, and therefore prevents the clearing out signal being sent. She then inserts her telephone plug into the jack of the line of the subscriber wanted and calls him. When he responds she tells him that he is wanted on trunk line No. 1 or No. 2, as the case may be, and he inserts his plug into the jack of that trunk line, after which the operator may withdraw the holding plug. When the private branch

subscriber hangs up, the disconnect signal is sent directly to the main office in the same manner as if he were on an individual line.

Such a system is employed only where the services of a special operator are not required at all times. The stations are generally all within reach of the sound of the bell on the attendant's desk, and therefore, if the attendant is not present any subscriber may respond when he hears the bell by plugging in directly into one of the trunk line jacks. If there are more than one of these he can usually tell which one by the sound of the bell.

Such a system is not universally adaptable, and is only applicable where a few stations are required and where a comparatively high-grade class of subscribers is to be found. Such a system would be rendered practically unusable if two of the subscribers, finding themselves on the same line at the same time, were not willing to give way to each other promptly. It will be interesting to watch the development of this class of service in the future, as, from its popularity when installed, there appears to be some reason for its existence.

Wireless Telegraph Theory.

In a paper read before the Nantes Congress of the Association Francaise pour l'Avancement des Sciences in 1898, Prof. Blondel presented a simple method of representing the disturbance of the ether produced by a vertical antennæ. This consisted of a polarized hemispherical wave, the electric lines of force being circular meridians and the magnetic lines of force circles of revolution. In a paper read before the congress of the same association held at Nantes in 1902, Prof. Blondel returned to the subject, prefacing the paper with a statement that various English and American authors had given different representations of waves, figuring them as elliptical tores of constant height sliding on the surface of the earth and increasing only in diameter (Fig. 1).

Prof. Blondel considers this view to be erroneous and resulting

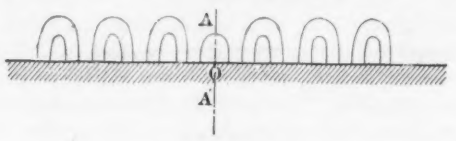
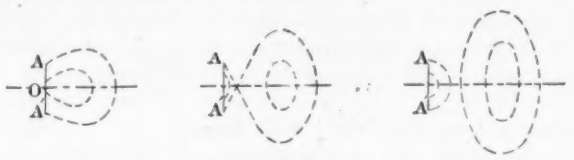


FIG. 1.

from an incomplete interpretation of the theoretical results of Hertz, on which they state they base their conclusions. It is easy to show, on the contrary, that the representation of the field in the vicinity of the antennæ which accords with the work of Hertz, is in perfect harmony with the production of long-distance spherical waves.

Prof. Blondel reasserts that the antennæ-earth system is equivalent to a Hertz oscillator of double length (AA', Fig. 1), attained by adding to the antennæ, OA, a symmetrical portion, OA', formed of its electrostatic image with respect to the surface of the earth, which latter plays the rôle of a conducting surface (the hypothesis of a perfect conductivity of the earth is evidently only approximate, but sufficient for the elementary theory). The field in the vicinity of this rectilinear oscillator (AA', Fig. 2), is analogous to that



FIGS. 2, 3 AND 4.

which Hertz investigated around a small rectilinear electrical oscillation.

This field is formed by a series of loops which close on themselves and then are detached and proceed perpendicularly to the wire of the oscillator and constantly expanding. The substitution of a finite rectilinear exciter for the small oscillation does not modify the phenomenon qualitatively, still giving us loops describing circles of revolution representing the field of force.

The manner in which the loops become detached can be deduced from the figures of Hertz as Prof. Fleming has pointed out, and may be explained with reference to the diagrams of Figs. 2, 3 and 4. The positive and negative charges, or electrons—to use the latest terminology—proceed in an inverse sense toward the opposite extremities of the exciter, but remain bound by lines of force, as in the case of any mass of electricity decomposed in its electrons. During the first part of this movement the electric lines of force form loops of increasing dimensions, as is shown for a given case in Fig. 1, then the propagation is subject to a reflection at these extremities and the loops close little by little (Fig. 2); next, owing to the inertia of the electrons, these pass beyond the position of equilibrium, O, and the lines cross, as shown in Fig. 3; finally after crossing, they separate into distinct loops, as is shown in Figs. 3 and 4, and the detached loops continue their course as free waves. The presence of the earth permits only the continuation of the upper halves of the loops.

But it should not be understood that the loops proceed by a simple movement of translation while retaining their form (Fig. 1), for the lines of force tend to spread out in all directions; they increase in height in the same time that they propagated along the earth, at which they touch practically normally as on any conducting surface. At the same time they curve toward the vertical axis of the antennæ, as in the case of experiments with Hertzian fields at small distances. The propagation of lines of electrical force should then, I believe, be represented in the form drawn in abridgement in Fig. 5. I say "in abridgement" because the spherical form is not, in

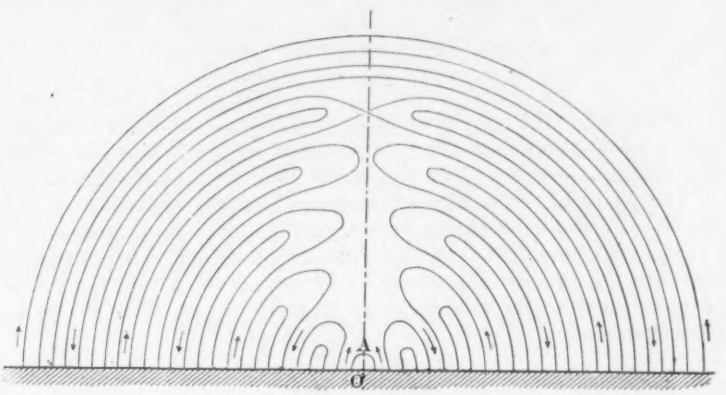


FIG. 5.

fact, attained as rapidly as that figure indicates, which is a simple diagram having no pretensions to mathematical exactitude.

This figure shows that little by little the loops in spreading out end by joining on the axis of figure and finally become perfectly spherical. From that moment the propagation will be purely transversal and with the velocity of light. Before attaining the limiting distance beyond which the waves are spherical, the field follows laws much more complex; the speed is not that of light, the lines of force oscillate as Hertz has shown, and the phenomena are complicated and difficult to analyze; for ordinary purposes, however,

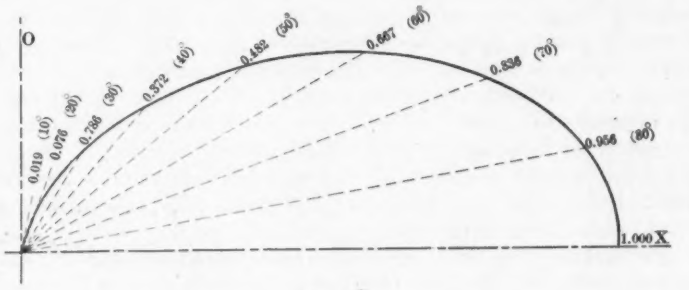


FIG. 6.

the schematical representation given will suffice, satisfying ourselves that an investigation of what takes place at great distance.

To this end it is necessary to make first a simple hypothesis on the oscillations of which the antennæ is itself the seat. The most simple is to assume that they are simply sinusoidal in function of time, like the oscillations in a music pipe open at the top and excited at the base. It results, in fact, from the experiments of Slaby and others that the antennæ when subject to normal permanent oscillations has always a node of potential and a crest of current at the base, and a crest of potential and a node of current at the summit (Fig. 7). If we neglect, lacking other recourse, the perturbations at the extremity where the wave reflections are produced (and experiments seem to give this right, for in charging the form at the extremity and adding there small spheres or plaques or various kinds

of points, no change in the length of wave is appreciable), and if we neglect also the variations of the capacity and of the linear inductance along the antennæ, the equation of the current can be written in the following elementary form:

$$I = I_0 \cos \frac{\pi^2}{2H} \sin \pi \frac{Vt}{2H}$$

in which I is the current at the point z and at the time, t; I_0, the amplitude of I; z, the height of the point considered, H that of the

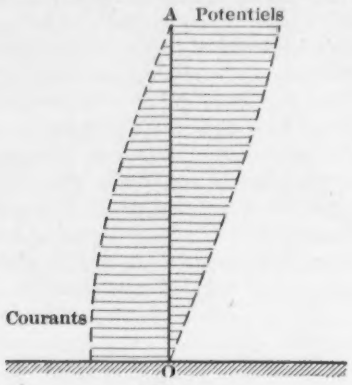


FIG. 7.

antennæ and V the velocity of light. This being assumed, an approximate calculation can easily be made showing the manner in which the energy is distributed on a spherical wave at great distances.

The paper of Prof. Blondel develops in detail mathematical expressions based upon the above assumptions. The result shows that the forces in the field vary as a function of the angle Θ_0, the angle between the direction of an element of current and a vector which is perpendicular to the electrical and magnetic forces, as is shown in the expression.

$$\frac{\cos\left(\frac{\pi}{2} - \cos\Theta_0\right)}{\sin\Theta_0} \quad (1)$$

On the other hand, the energy varies perpendicularly to the radial vector of Poynting, or according to the expression,

$$\frac{\cos^2\left(\frac{\pi}{2} - \cos\Theta_0\right)}{I_0^2 \sin^2\Theta_0} \quad (2)$$

It is easy to see that the reception depends upon the energy received by the antennæ; this is evident for thermic or other analogous receptors which integrate the energy received in unity of time, but is equally true for receptors of the coherer type, which are sensitive to electric shock received upon the arrival of each train of waves. In fact, one ordinarily defines the condition of coherence by the voltage necessary to produce it; but it is evident that in order to obtain the soldering of metallic particles there is also necessary a certain minimum quantity of electricity; that is, it is the product of the current by the potential that determines coherence. Now, two antenna of equal height can give rise to an equal e.m.f., but that which has the largest surface gives rise to the largest quantity of electricity and produces consequently the better effect at the receiver, as may be readily determined. It is, therefore, the energy received by the antennæ in the form of electric and magnetic lines of force which affects the reception. The sensitiveness may be considered as proportional to the radius vector, the expression for which, $r = r_0 - z \cos\Theta_0$, forms part of the calculation above referred to.

It is thus seen that the effect of waves decreases inversely as the square of the distance and not inversely as to the distance according to the theory of Taylor, which has recently been criticised by Prof. Fessenden. On the other hand, if we consider in function of the angle Φ, the curve corresponding to the factor (2), we obtain relative values represented by the vectors of Fig. 6. The following table indicates these relative values in function of the radius directed according to the horizontal taken as unity:

$\Theta_0 =$	0	.019	.0176	.185	.312	.482	.667	.836	.956	1.0
	0	10	20	30	40	50	60	70	80	90

We see that the energy decreases rapidly as we arise above the horizon; the preceding theory, therefore, accounts for phenomena observed by various experimenters. In France, in particular, Capt. Ferrié has received signals in a balloon at heights of some hundreds of meters above the earth and distinctly observed the rapid decrease of reception with height. In addition, it is quite evident that the curve of distribution preserves the same form at all distances; but the further one is away the less can he be from the earth to receive perceptible signals, since the energy decreases in absolute value.

This theory, which assumes the earth to be a perfect conductor, applies directly to transmission over the surface of the sea; it is, however, only approximate in the case of propagation over earth only slightly conductive, which then is to be considered a semi-dielectric. When the waves propagate themselves to great distances the curvature of the earth intervenes; but it does not interfere with the propagation, as we know from the propagation of waves along conducting bodies; the waves turn in in such a manner as to follow the surface, as has been shown by the experiments of Sarrasin, de la Rive, Blondlot and others.

To resume, the simple application of known properties of Hertzian waves are sufficient to explain in a satisfactory manner all the phenomena observed without it being necessary to attribute to waves new or mysterious properties. In this note I have confined myself to rendering clearer the interpretation of the phenomena, and to explain how, notwithstanding the very complex conditions and the difficulty of analyzing what passes in the vicinity of the antennæ, the propagation at great distances resolves itself simply to that of hemispherical waves, as I showed in 1898.

Hemispherical waves are polarized waves; it is for this reason that they do not propagate energy in an equal manner in all angular directions, and present a maximum effect toward the horizon and no effect toward the zenith.

Transportation in Brooklyn.

The December Grand Jury of Kings County, Brooklyn, N. Y., has filed a presentment on the street railway system, which it considers wholly inadequate. A local body of electrical commissioners with power to secure remedies is demanded. The presentment says:

The third-rail question, one which affects our people to the greatest degree in view of the many accidents which it causes, thanks to the careless methods of the companies as far as relates to the repair of their rolling stock and electric appliances, is, we are assured, receiving the careful attention of the heads of the corporation. It is possible that in time, when a method will be found cheap enough to be attractive which will lessen the perils caused by that means of electric traction, the management will adopt it, if it ever becomes convinced that it will prove cheaper than the eventual payment of damage suits resulting from accidents. But here, again, there is no one empowered to make them adopt the safety device, be it ever so perfect.

It is readily seen that as there are no laws to govern the case, no ordinances to be enforced, no authority whose province it is to enforce them, cars will continue to be overcrowded, the service will continue to be irregular, people will continue to be subjected to freezing temperatures and drafty vehicles; the lack of headlights on trains, the electric current of the third rail, defective insulation due to slovenly repairs in the machine shops, will continue to kill and maim people, and there is no redress but the verdict of "accidental homicide" on the part of the coroner, or at best a verdict for damages on a case where the negligence of the corporation is too flagrant.

In order to afford some remedy, the few laws and ordinances which have been enacted must be complied with, and freed from any ambiguity which makes their execution impossible. Others af a stringent nature, though perfectly fair and reasonable, providing severe penalties for infraction, must be passed by the competent authorities, Legislature, or council, under the clause of the public welfare and safety, and their enforcement should be intrusted to a local body of electric railroad commissioners.

To this end, we, the December Grand Jury of the Borough of Brooklyn, call upon the proper authorities, municipal assemblies or State Legislature, or both combined, to give us without undue delay, a proper code of laws specifically enacted to govern the local transportation companies. These laws, while protecting fully the franchise rights of the transportation companies, and enacted with due fairness to all, must clearly define the rights of the citizens, and regulate the mutual relations of both in the process of transportation.

The Effect of "Wireless" on Improvement in Wire Telegraphy.

BY JOSEPH B. BAKER.

IN the summer of 1902 there was a controversy in the columns of THE ELECTRICAL WORLD AND ENGINEER between Messrs. Delany and Barclay, that constituted the latest chapter in the old dispute between the supporters of conservative methods of handling telegraph traffic and the believers in the application of more modern and speedier methods of transmission to the benefit of the public service. In an article in these columns in the issue of July 19, 1902, the present writer drew attention, first to the apathy of the telegraph companies, expressed by their indifference to the progress that had been made in rapid telegraphy systems; and, secondly, to the unquestionable fact of the existence of practical systems for enormously increasing the transmission capacity of existing lines—systems that are far beyond the experimental stage and quite ready to be put into use. In this communication it is sought to show how the present aspect of these two related facts, truer than ever as they are to-day on their own merits, is affected by the work that has been done in the last few years in the art of telegraphing without wires.

Marconi and the earliest workers in space telegraphy were soon obliged to realize that the matter of signalling through space meant dependence upon a new set of *natural* phenomena. They were able to signal only by the application of electric energy in a form natural and proper to the sending circuit including an elevated conductor, whereby a distant similarly arranged receiving elevated conductor and circuit upon which could impinge a minute fraction of the original energy borne by the ether as a non-conducting medium of propagation, was made to reproduce the signals. Only by such application of electrical energy, namely, the generation of Hertzian waves by oscillating currents natural and proper to the circuits of the terminal apparatus, could signalling without a connecting line be effected over more than moderate distances. This is illustrated by the facts that the electrostatic induction method of Edison, being dependent upon what may be called forced ether strains due to current flow between capacity area and ground at unnaturally low periodicity, was not effective beyond very moderate distances; while the free discharge at the spark gap of Marconi's vertical wire, whereby the wire, situated favorably for disturbing the ether surrounding it, had its electric charge set into natural vibration, has been developed in a comparatively few years to the point of transatlantic signalling under favorable conditions.

The early observed fact that a receiving antenna and circuit similar to such apparatus at the sending end constituted a pair of stations capable of working through distances very great compared to the distances that could be covered by dissimilarly arranged stations, was the first step toward modern syntonic space telegraphy. Experimenters in "wireless" had to attack the problem of tuning, not at first, indeed, or even as yet for the sake of rapid telegraphy by the new method, but for the sake of being able to signal at all. In a word, the development of the new art left no escape from the fact, held in abeyance as long as wire telegraphs were the only ones in use, that the signalling energy should be of a form proper to the apparatus and medium of propagation used. The desirable in wire telegraphy, the scientific method of signalling, hitherto neglected and despised by telegraph companies satisfied with crude and primitive methods, became for "wireless," wherein the connecting "line" was absent, an absolute essential of commercial operation. The wire telegraph works, to the satisfaction of vested interests controlling it and of an unenlightened public, by an electrical use of the wire as crude (in comparison with what might be gotten out of the line by adapting the constants of the terminal apparatus and the frequency of the signalling electromotive forces to the constants of the line) as communication by hammering on the end of a steel rail to be heard at the other end compared with conversation by telephone.

"Wireless" work and achievements now place existing systems of rapid telegraphy, the work of some of the best brains in this country, in a new light; and show more clearly than before the advantages—hitherto absolutely ignored and wasted—inherent in the having of a conductor, connecting the sending and receiving stations, able to give direction to the wave-borne signals. Such a connecting wire is easily able, also, to become a main-traveled road for many sets of signals, each set transmissible at a speed so far in excess of that attained by the present handwritten "Morse," as to be in a wholly different class, by the simple plan of using the transmission line as it should be used; that is, the plan of applying the signalling energy in a form natural and proper to the electrical constants of the line and its terminal apparatus. These considerations, in the eyes of workers in wireless telegraphy, suggest improvements of incalculable value in wire telegraphy. The having of a conducting line to carry the signalling impulses with but little loss (comparatively speaking) directly to the receiving station, reduces the realization of these improvements to a simple matter of providing multiple-tuned sending apparatus and corresponding receiving apparatus, in the use of which the capabilities of a single wire become at once so exalted over its present use by "Morse" as to make this single wire more than the equivalent of a heavy pole line with each wire quadruplexed.

All this raises the question: Can the telegraph companies continue to resist progress in rapid telegraphy? With a public gradually becoming enlightened upon the whole broad subject of electrical waves, and welcoming the rapidly spreading use of machine telephone operation with its revolutionizing effect on that important traffic; with the existence of practical rapid telegraph systems already many years old and comprising the work of men of the most unquestioned eminence in applied electricity as well as in the narrower field of telegraphy; and finally, with the existing lines coming to be recognized by an enlightened public as being entirely capable of use in the carrying of an enormously greater business with corespondingly lower rates than at present, will it be much longer possible for conservatism and indifference to public need to maintain outworn and primitive conditions?

Telephone Transmitters.—III.

BY ARTHUR V. ABBOTT, C. E.

THE perfection of the solid back marked an important era in the development of the transmitter. It was so successful that since its completion the American Bell Telephone Company have discontinued the use of other forms and have gradually replaced those of earlier construction with the solid back, until now it is rare to find any other in use. Since the original design of Mr. White there has been little change in the solid back, excepting in minor matters of detail, and when the patent situation became such as to invite the more courageous of independent telephonists to undertake the manufacture of transmitters, the first effort was to copy the solid back in an attempt to produce a model which should equal it; so the majority of transmitters upon the market are more or less close imitations thereof. In most respects the attempt has been made to keep each transmitter as near as possible to the original type without patent infringement, but some builders have shown considerable ingenuity in changing the details of construction and some have even gone so far as to entirely depart from the fundamental principles. Transmitters, therefore, can be divided into three classes:

1st. The solid backs, or those which are, to all intents and purposes, copies of the White.

2nd. The elastic cell transmitter, in which there is no secondary flexible diaphragm, but the receptacle containing the carbon is made of elastic material (such as a ring of felt) and the diaphragm is pressed directly against this ring. Such instruments are described more forcibly than elegantly by the term of *"Cornplaster"* transmitters.

3rd. Double diaphragm transmitters.

Considering the first class, the transmitter manufactured by the Kellogg Switchboard & Supply Company is a prominent example. A full-size section through the Kellogg transmitter is shown in Fig. 17. In Fig. 18 the rear cap is removed. In Fig. 19 the instrument is entirely dissected and in Fig. 20 a front view of the diaphragm is shown. The section of Fig. 17 shows the instrument to consist of a solid face plate, *a*, which is almost exactly similar to that of the White instrument. A hard rubber mouthpiece, *a*, is threaded into a hole into this plate. There is a perforated partition just in front of the diaphragm, the object of which is to prevent injury to the transmitter from the too curious, who often like to investigate a telephone by poking it with a lead pencil. Across the base plate and bolted thereto a substantial brass bridge, *h*, is placed. As

shown in Figs. 18 and 19, this bridge differs from that used in the White instrument in being perfectly straight. The diaphragm, *b*, Fig. 17, is made of aluminum essentially the same size and thickness as that used in the White transmitter, but possesses a distinct feature in that the receptacle to hold the front electrode and the granular

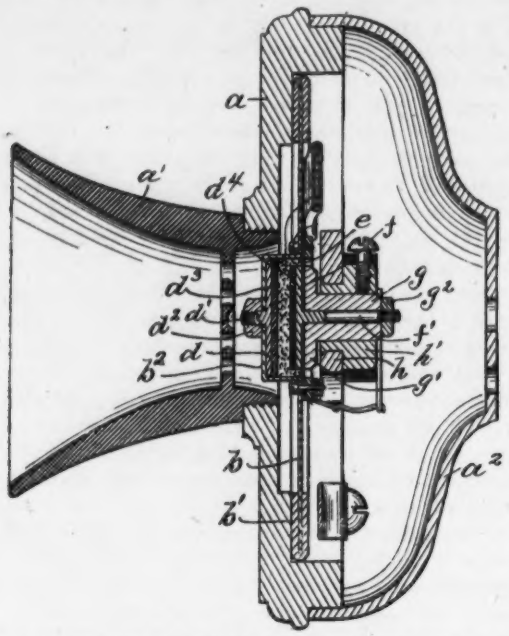


FIG. 17.—SECTION OF KELLOGG TRANSMITTER, FULL SIZE.

FIG. 19.—KELLOGG TRANSMITTER DISSECTED.

carbon is formed in the diaphragm by pressing a cup-shaped depression in the center.

This construction is shown clearly in Figs. 19 and 20. The front electrode, d^3, Fig. 17, is a thin, flat piece of carbon highly polished and brazed to a brass disc, *d*, furnished with a short, small stem, d^1. This is inserted in a hole drilled in the center of the bottom of the cup pressed in the diaphragm and by means of the nut, d^2, the electrode is clamped in its place. The rear electrode, d^4, in Fig. 17, is formed of a similarly shaped disc of carbon about ⅛ in. less in diameter than the front electrode. It is also brazed to a brass disc provided with a shank, f^1, placed in the center of a circular mica disc, *e*. On the outside of the mica disc a brass nut, *g*, is slipped over the shank, f^1, and clamped by means of the nut, g^2. The necessary amount of granular carbon is placed in the cup, the rear electrode inserted; the mica washer then covers the entire opening of the cup. A thin aluminum ring is then placed over the mica washer and riveted. This hermetically seals the electrodes and enclosed carbon. The shank of the brass disc, *g*, is then inserted in the bridge and clamped in its proper place by a set-screw. By this design the rear electrode is clamped firmly against the bridge, but the entire cup containing the front electrode and carbon vibrates with every motion of the diaphragm. So the first essential difference between the White transmitter and that of the Kellogg Company is that in the White instrument the carbon receptacle is fixed and in the Kellogg instrument it is movable. It is claimed that this motion of the carbon receptacle is efficacious in preventing packing, because the carbon is constantly in motion. This has not conclusively been proven, and it is doubtful if the motion of the diaphragm is sufficient to be of material aid in stirring up the carbon granules. There is much evidence to show that prevention of packing is more a matter of mechanical design in obtaining the relative, proper sizes of electrodes, diameter of carbon receptacle, thickness of layer of carbon and proper sizing of the individual granules, than to any method of stirring up the transmitter in order to release the granules from a clamped position. The circuit of the Kellogg transmitter is very

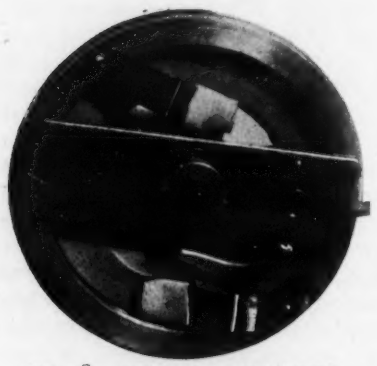


FIG. 18.—KELLOGG TRANSMITTER, CASE OPENED.

FIG. 20.—KELLOGG TRANSMITTER DIAPHRAGM.

FIG. 21.—GROUP OF TRANSMITTERS.

similar to that of the White, inasmuch as the diaphragm is connected to an insulating binding post placed upon the bridge, to which one of the line terminals is attached. This affords electrical connection

FIG. 22.—AMERICAN TRANSMITTER WITH COVER REMOVED.

FIG. 23.—AMERICAN TRANSMITTER DISSECTED.

with the rear electrode. The front electrode is insulated by the mica washer and the rubber ring which encloses the diaphragm. Therefore, by connecting the other line terminal with the transmitter case, circuit is obtained through the carbon granules.

Not only in the general principles of construction, but also in exterior conformation the various transmitter manufacturers have closely adhered to the design of the first solid back. This is evidenced by Fig. 21, showing a group of six well-known transmitters, of which the following is a list:

A. Swedish-American transmitter.
B. Wilhelm "
C. Intensifying "
D. Manhattan "
E. Century "
F. Ericcson "
G. Williams "

These instruments and a few other models will be described somewhat more in detail.

The American Transmitter.—The transmitter manufactured by the American Electric Company is shown in Fig. 22, with the cover removed, and in Fig. 23 entirely dissected. It consists of a heavy face plate carrying an aluminum diaphragm, cushioned by a rubber strap. Across the face plate a brass bridge is screwed, as shown in Fig. 22, the capsule being included between the diaphragm and the under side of the bridge. The cover of the transmitter is a hemispheric case of spun brass fastened by two specially-formed nuts, which prevent its removal excepting with the aid of a particular tool which will fit the nuts in question. In Fig. 23 the bridge is removed and turned upside down. The capsule containing the granular carbon consists of a thin spun brass cup, over the face of which a mica diaphragm is placed, and the entire capsule closed by spinning a brass washer over the mica and the edge of the cup.

Lighting at the St. Louis Fair.

The contract for lighting the World's Fair, which has been awarded to the General Electric Company, is the largest exposition illumination contract ever let. It provides for supplying the Exposition with 300,000 incandescent lamps at 13.6 cents each, or a flat outlay of $40,800. This contract for lamps followed the completion of sketch plans for lighting the exhibit places, grounds and architectural features belonging to the Exposition proper, but is exclusive of state, national and private concession buildings. The detail plans are now being drawn.

To give an idea of the distribution of these lamps, it is stated that 12,000 are to be placed on the Palace of Education alone. The classical outline of that building eliminates brilliant color effects, but furnishes a splendid setting for night effects produced by electric lights.

It has been decided to place on each of the monumental standards which dot the main avenue of the Exposition, on the border of the waterways, 24 incandescent lamps. Each of these standards has four cast-iron pendants, on each of which there will be six lights. The "Pike," or Midway, will be furnished with sufficient lights to render it brilliantly illuminated. Each of the standards along the central avenues will hold 24 lamps, so distributed that 12 will hang on each arm of the supporting post.

The lamps contracted for will be used exclusively for exterior lighting. The interior of the exhibit buildings, which will be closed at sunset, will be lighted with arc lamps, the chief object of this lighting being for patrol purposes.

The western half of the north facade of the Educational building has been equipped with lamps. This is merely a test section, installed for the purpose of trying the effect of lights between the columns. Results of the tests have proved satisfactory in every way.

Cleaning Third Rail.

Cleaning the third rail appears to have been done successfully by the Grand Rapids, Grand Haven & Muskegon Railway Company, which has an exposed rail and is operated through an open country. A solution of chloride of calcium poured on the third rail has instantaneously removed a covering of ice or sleet, and, moreover, protected the rail so that it has not covered again with ice for at least three hours. These tests have also shown, it is said, that the solution will not injure either the steel rail or the copper bonding. Three cars on that line have been equipped with reservoirs, located in the motorman's vestibule, from which tubes extend to a point directly over the third rail. In this reservoir the solution is placed. A stop-cock regulates the flow of the fluid.

Mr. George Westinghouse.

One of the customs of the Westinghouse Electric & Manufacturing Company is to have an annual reunion at its works of all the district managers, and a social feature of these occasions is a dinner where the visiting delegation meet in familiar converse with the principal members of the technical and other staffs of the works. At such a meeting several weeks ago Mr. F. H. Taylor, second vice-president, took occasion to make some remarks having for a subject Mr. George Westinghouse, in which he presented a character sketch intended to meet the interest of those present who did not know Mr. Westinghouse intimately, or who might know only of his activities in the field of their own work. The remarks naturally were not intended for publication, but realizing the interest they would have to our readers as an intimate portrait presented thus informally by a close business associate, we requested a copy for reproduction in our columns. Having finally overcome the reluctance to publicity for remarks delivered under the circumstances, we are enabled to give below Vice-President Taylor's address, which we believe will be read with much interest.

GEORGE WESTINGHOUSE:

Mechanic;
Inventor;
Tireless organizer;
Financier;
Friend of labor;
Founder of enduring industries.

What all the world knows needs only to be mentioned to you who are his associates in business.

The revolution in railroading wrought by the developed air brake;

The appreciation of an opportunity that recognized the importance of the discovery of natural gas in the Pittsburg district and controlled its development;

The resourcefulness and ingenuity which won the great victory at the World's Fair in Chicago;

The courage that triumphed over the difficulties of a financial crisis;

The power that has grown so fast as to keep ahead of the unparalleled increase in the industries started but a few years ago, and now appalling in their size and extent;

The executive ability that has been the controlling factor in the Westinghouse interests, which have become so numerous that no one here in an hour's time could write out a list of them and have it complete.

These interests have grown so large and the number of responsible officers has become so great that Mr. Westinghouse is not as intimately known to you as I should desire, and as I am sure he himself would desire if it were possible.

Some of the peculiarities which have aided him to acquire his present position may be illustrated. For example, it is unusual for an inventive genius to be so perfectly open-minded to the inventions of others. I sometimes think he is as happy over the discoveries of other minds as though they were his own. (He has found a means for the development of new inventions all his life.) Great intellects have worked for him, been encouraged by him and been protected by him. I name at random: Shallenberger, Tesla, Scott, Parsons, Nernst, Ruud, Cooper Hewitt, Thomas, Davis, Bremer, Lamme, Wurts, Lange. His mind is constantly reaching out into the future, and after one has been much with him it becomes practically impossible to live altogether in the present, because there is brought to view at every turn possibilities of new things yet undeveloped which are to serve future generations at a time when the world has advanced far beyond its present stage. The imagination is constantly stimulated and interest kept alive by the new principle that is struggling on towards definite shape.

There is always present the evidence of good will toward every one; a quick appreciation of the good points of other people. In the course of his life he has been forsaken by friends who lacked courage to follow him, and in its main crisis he was greatly hampered by heart-breaking incidents of this kind. Yet no one has ever heard him say an unkind word of any who differed with him. His foresight is phenomenal. The industries in this country have grown up even faster than seemed wise to a great many who were associated with him. They did not see the value of what he was doing as clearly as he saw it, and time alone has justified the thoroughness with which plans have been laid, buildings designed and executed. Energy and expense have not been spared upon any of the works. They have been developed in such a way that they can be extended forever.

No sooner had provision been made for this country than many of his closest friends were startled by a move upon Europe and the markets of the world. Some men have charged this move to a mere ambition to plant his name in Europe. They wondered that he should tax his resources and take upon himself the tremendous strain which has finally resulted in the great organizations and plants in England, France, Russia and Germany.

The associates who questioned his wisdom did not have his foresight and did not see that these things were necessary for the protection of the initial developments in the United States. I give no importance to my own judgment in this matter, but Mr. Westinghouse knew that the foundations here would have been insecure had not the foreign field been entered during his period of maximum activity. We shall live to see all the effort justified, and the Westinghouse interests the world over fitting together and helping one another.

After all, what is the ultimate aim of it? Men work for wealth, for social position, for the esteem of professional associates, for the applause of the world. These things may be nominated ambition and of that all men must plead guilty.

In the case of Mr. Westinghouse the aim is not immediate wealth. He has done his work too thoroughly to have that as his goal. From my closer observation of him I should determine that he meant to leave a monument upon the earth that shall be strong enough to stand alone without consolidation with other interests, and that shall bear his name for a hundred years. Napoleon's words to his brother when he was made ruler of Spain were: "My one word of advice to you—be master," and I anticipate that the Westinghouse interests will be master of anything they associate with during the next century. By that time the appreciation of what Mr. Westinghouse has done for the world will be clearer and more just than it is to-day.

Great men cannot be compared one with another. They are moulded by circumstances and no two are alike any more than two great trees are alike, yet no man is truly great who lacks certain essential qualities: First, he must at all times be just, and in the case before us this quality has prevailed. A great nature shows itself by being kind and considerate. The underlying sweetness of his spirit is illustrated by the watchword that he uses among all his interests—a constant repetition of a plea for harmonious action. Other virtues are shown by the cleanness of his life. You who have, at times, worked for other kinds of men must know the power that comes to those who work for a clean man, and one who demands soundness of thought and expression. He is never satisfied with surface appearances, but seems to look right through to the heart. His mind is so quick that he sees the essential point in a complicated situation even before the story can be fully told to him. Once determined upon his course, he is not to be laughed out of it, frightened out of it, nor bought off.

The boundless hospitality of his home has been often mentioned, but when one has had the opportunity repeatedly of seeing him there, he is impressed with the uniform cheerfulness of the man and of his sustained interest in every detail of household life. I saw somewhere a letter from a wife written upon the birthday of her middle-aged husband. In the letter this sentence appeared: "To me, you will always be my young lover." This one sentence defines Mr. Westinghouse in his home.

To one associated with him in business, it has often seemed that to be loved of the man is an aim worthy of a life of devotion to his interests.

I have referred to the fact that all men have their ambitions. Every one here is anxious for a broader field, and I am sure will attain to it. Yet every one of us has arrived at an age when we can make a fairly good estimate of our probable attainments. This is our annual dinner and it is a good time to take an account of stock. My judgment is that there is in our organization an opportunity for every man to be satisfied. For myself, first of all, I want a conscience void of offense. Next, I want to leave some record in the world for my family. I should like to be remembered as one who has accomplished something. I, too, want to leave a monument. My ambition is not for popularity nor for fortune. I am satisfied if I leave my children the inheritance that their father had been able to catch something of the spirit of a great leader, and that he had been somehow useful in perfecting that leader's work and in developing his plans. For me it shall be enough that I served under George Westinghouse; that I was counted one of his efficient lieutenants.

CURRENT NEWS AND NOTES.

A NEW ELECTRICAL DICTIONARY.—An electrical dictionary is now being prepared in France, which will be published in three volumes, each of 700 to 800 pages. Prof. J. Blondin, of the Sorbonne and editor of our French contemporary, *Eclairage Electrique*, will be the author.

A CORRECTION.—In the article by Prof. R. A. Fessenden, appearing in our issue of November 14th, the statement on the sixth line below the cut showing a mast, should be "12 or 13 interfering stations," instead of "135 interfering stations."

LONG DISTANCE RECORD FOR ELECTRIC AUTOMOBILE.—The world's record for long distance run by an electric automobile, on one charge, has been established, according to a Washington dispatch, by Mr. F. B. Whitney, clerk of the House Committee on Naval Affairs. On December 23rd, Mr. Whitney made a run of 121 miles in 10 hours and 32 minutes—an average speed of 12 miles an hour.

STORAGE BATTERY SEPARATOR.—The only electrochemical patent granted on December 22nd refers to a separator for storage batteries, invented by Mr. Hugh Rodman. About a year ago Mr. Rodman patented the use of a wooden diaphragm between each pair of plates of a storage battery, the diaphragm having acid wells. The object of this separator was to provide free circulation of the acid from the top to the bottom through vertical grooves or wells cut on the sides of a wooden sheet. While any kind of wood may be used, yet porous or fibrous wood is preferable. In that patent it was stated that diaphragms of wood possess unique and remarkable properties which adapt it for the purpose, and the properties mentioned there were efficiency, durability and capacity. These separators have evidently found extended use in practice, and it has thereby been discovered that where the wood comes in contact with the peroxide of lead of the positive plate, the nascent oxygen causes deleterious rotting of the wood. In his new patent Mr. Rodman therefore provides means for keeping the wood from coming in contact with the lead peroxide. These means may, for instance, consist in a sheet of rubber, or the grid of the positive plate may be provided with projections which touch the wooden diaphragm, while the active material does not come in contact with the wood. The inventor states that the term "wooden" is intended to include such materials as paper and other cellulose fibre products.

ROWLAND'S EXPERIMENT.—Several years ago M. Cremieu, as the result of experiments, questioned the accuracy of Prof. Rowland's epochal experimental proof of Maxwell's great hypothesis on the identity of electromagnetic and luminous undulatory transmission. This proof consisted in demonstrating experimentally that if a static discharge were to move with the velocity of light, it would have the effect of a current. At the suggestion of Prof. Rowland, Mr. Harold Pender made experiments at Johns Hopkins University with the method of Cremieu, but got results which corroborated instead of contradicted Rowland's proof. With the hope of reconciling these contradictory results, M. Henri Poincaré undertook, in the fall of 1902, to bring about a collaboration between M. Cremieu with Pender, and at the suggestion of Lord Kelvin, Paris was chosen as the most favorable place for the proposed joint experiments. The Carnegie Institution furnished the funds necessary to defray the personal expenses of Mr. Pender, the expenses of actual experimenting being met by the Institute de France. The result of the work was communicated in the form of a joint paper to the Société Francaise de Physique, a translation of which appears in the current issue of the *Physical Review*. The work of the two experimenters, as described in this paper, is a beautiful example of scientific investigation, the result of which was to confirm absolutely the accuracy of Prof. Rowland's proof. The joint experiments disclosed a fundamental inaccuracy involved in the experimental apparatus of M. Cremieu due to the kind of dielectric employed, which exercised a screening or neutralizing effect due to the very considerable charges absorbed by the particular dielectric employed in an essential part of the experimental apparatus.

LETTERS TO THE EDITORS.

A Singing Vacuum Tube.

To the Editors of Electrical World and Engineer:

SIRS:—It may perhaps prove of interest to your readers to know of a certain phenomenon which the writer observed recently during some experiments with Röntgen-ray and cathode-ray tubes. Possibly some of your readers may have observed similar phenomena, or can suggest explanations other than those which have occurred to me.

Over a week ago, during some experiments, I had the misfortune to perforate the target or anode of one of my Röntgen-ray tubes, and this, in addition to destroying its focusing power, caused the vacuum to lower as the occluded gases in the platinum were driven out. The tube was one of the Queen self-regulating type with the platinum plate of the anode backed by nickel. I laid the tube aside and ordered a duplicate, intending to send the damaged tube to be repaired. A few evenings thereafter (December 24, 1903), I was on the point of packing this latter tube in a large cardboard box filled with excelsior when it occurred to me to try it once more and see if its vacuum had changed and to what extent. After heating the target or anode red hot I laid the tube down upon the closed cardboard box, taking up the new tube and placing it in the holder. Suddenly I heard a low but very clear musical note corresponding to *A* on the musical scale, and which I found came from the damaged tube. On placing my hand on the tube at various parts I could feel it vibrating violently.

I timed the duration of the sound on three separate tests and the musical note lasted respectively 5, 15 and 7½ minutes; in other tests made since it has lasted from 5 to 17½ minutes. Sometimes the tube did not start when first laid down, but invariably tilting and letting it fall back lightly would start it up. Sometimes after it had stopped I could start it again a second or third time without connecting to the coil. The pitch of the sound was always the same save on two occasions, when several persons were talking near the tube; the pitch then varied, but when the room became quiet it resumed its usual pitch. The amplitude of the sound varied, but could usually be heard plainly in an adjoining hall or room from 20 to 30 ft. distant. It should be noted that at the time the tube was singing, the induction coil, which was supplied from the street direct-current lighting circuit of 117 volts, was not running, nor was there anything else near to affect the tube either by an electrical or mechanical vibration; besides, the box and excelsior packing were a perfect cushion. I found that the tube laid on a table or a box sang just as well, and when I placed a long steel needle between my teeth, allowing the point to touch the bulb, the sound immediately ceased, but started up again each time the needle was removed.

By reason of the fact that it was necessary first to warm up the platinum plate by the cathode stream, and as the anode tube was not only perforated but part of its edge expanded away from the nickel backing, one would naturally be led to think the phenomenon was akin to the well-known "Trevelyan Rocker" effect described in most books on Physics, in which the vibrations produced by a heated brass rocker resting on lead give out a clear musical note, although it is impossible to detect the rocker vibrating. Whether the phenomenon is due to the Trevelyan effect or whether instead of a thermal action the musical note was caused by the air between the platinum and nickel plates which was forced through the perforated anode or not I am at present unable to state; but having observed in the *Sun* of December 20 a cablegram from London referring to some experiments in that city, the dispatch stating that a vacuum tube which had been lighted up continued to remain illuminated for ten days after it had been disconnected from the electrical circuit, I have wondered whether it were possible that the conditions of vacuum and perhaps other characteristics of the London vacuum tube and the Röntgen-ray tube were such that after the energy supplied electrically had set the tubes going, they may have been so extremely sensitive that they responded to some etheric vibration which kept them active until they got out of step. In the case of the Röntgen-ray tube, this would soon occur, as the conditions were changed by the cooling of the electrode. Such a stimulation by vibrations in the ether has been suggested by Mme. Curie, Edison, Lord Kelvin and others as one of the theories to account for the phenomena of radioactive substances such as radium, which acted as a transformer. Is it not possible that the light in the vacuum tube and the sound in the Röntgen-ray tube might have been similarly kept going? The writer was particularly interested in the statement cabled from London, as he has frequently called the attention of friends to the curious

effects produced upon a vacuum tube presented by Mr. D. McFarland Moore in 1896, and which has ever since been hanging in my laboratory, which tube would flash up at times long after the coil had been stopped and the tube disconnected. It was this sensitiveness to Hertzian waves which led the writer to suggest years ago the use of the vacuum tube as a receiver in connection with wireless telegraphy.

NEW YORK. WILLIAM J. HAMMER.

Theories in Wireless Telegraphy.

To the Editors of Electrical World and Engineer:

SIRS:—I have just read with much interest the letter printed in your issue of October 31st from Professor Fessenden, and I was pleased to note the allusion which he was kind enough to make to my publication of 1898, which preceded that of Mr. Taylor. I agree in part with the views of Professor Fessenden, but am not in a position to judge completely since I have not at hand the paper printed in the *Transactions* of the American Institute of Electrical Engineers in 1899, to which he refers. I would only observe that in my opinion there is no need to invent any new kind of wave, as Professor Fessenden appears to do, in order to explain phenomena which the simple theories of Hertz interpret sufficiently well. To render clear my views on this subject, I enclose herewith a short note which I presented last August at Angers before the Association Française pour l'Avancement des Sciences, for the purpose of rectifying the erroneous ideas put forth by Mr. Taylor and others, and to complete the earlier communication, which was not sufficiently full.

As will be seen from this note, it is sufficient to consider the earth as a conducting surface (which is quite true in the case of the sea, and an approximate hypothesis in the case of the earth) along which the lines of force glide, in order to explain very simply the propagation of waves and the hemispherical form they assume. Still more, the very simple formulas that can be established by means of this hypothesis show that the energy received by an antennae is a maximum at the surface of the earth and decreases rapidly at distances therefrom; and that it diminishes inversely as the square of the distance, as in all cases of spherical propagation.

The electromagnetic theory such as I have developed it should not be made to bear the burden of errors resulting from a misapprehension thereof. If Mr. Taylor, who starts with entirely correct ideas, ends by finding a decrease of energy in inverse ratio with the distance, this is merely because he attributes to half waves a constant height and does not permit them to acquire their natural development in space. Experiments made in balloons by several Frenchmen, notably by my friend Capt. Ferrié, of the Engineers, have shown that propagated waves can be detected at very considerable heights. If Professor Fessenden has found this height very limited it is, I believe, simply because the energy decreases rapidly as the distance from the earth increases, as indicated by an energy curv which figures in my note; but one should not confound the lack of sensitiveness of apparatus with the lack of existence of waves.

The researches of Professor Fessenden do not appear to be any more conclusive (at least until I have read his complete publication) as concerns the necessity of adding a metallic conductor of half a wave length beneath the antennae; experiments which we have made in this connection in France have shown that it suffices to have very large metallic surfaces in communication with the earth; indeed, the earth connection may be entirely replaced by a very large metallic capacity. In the experiments, for example, of Capt. Ferrié, he found that a large metallic capacity may be placed at the summit of a tower. using suspended antennae without earth connection, and signals received over a certain distance. The earth serves with respect to the antennae only as a large capacity to store the oscillatory charge constantly passing between the capacity and the antennae in a manner to give rise to sufficient current to affect the indicating circuit.

Nor does it seem to me that sufficient account is taken of the very great sensitiveness which can be obtained with a coherer of gold or pure silver filings, when employed in the manner which I indicated in 1898 (*Comptes Rendus,* April 23, 1900) in combination with a potentiometer. This disposition enables the voltage necessary to produce coherence to be reduced to a very small amount, and permits the voltage of the potentiometer to be put in series with that of the antennae; under these conditions the slightest e. m. f. produced in the antennae suffices for coherence, and one has thus a filings coherer of very considerable sensitiveness, and much greater than ever obtained by Marconi. In France we have experimented with several of the later receiving systems, such as those of Solari and Marconi (hysteresis receivers) without obtaining as great sensitiveness. This does not prevent me from recognizing the interest presented by the employment of the telephone; indeed, I think I was the first to indicate this interest in 1898, when I made it a subject of communication to the Académié des Sciences, May 21, 1900. The arrangement of Prof. Fessenden, which we have not yet been able to test, will indeed be welcome if it involves a sensitiveness as great as he gives us to hope.

Having re-read the article by Mr. A. Frederick Collins on the very interesting discoveries of Professor Fessenden, I beg here to point out that his system of syntonization by groups of waves, described in the patent to which Mr. Collins refers, is anticipated by an application which I have filed for a United States patent along the lines of my English patent of May 3, 1900; and his arrangement for the continuous production of waves recently described appears analogous to one for which I was granted a British patent, July 11, 1902.

These claims, which I make here incidentally, are not intended to detract from the scientific merit of the researches of Professor Fessenden, to which I render homage; and I shall be particularly happy to see published with more detail the curious experiments on the propagation of wave to which Mr. Collins refers briefly. The scientific world will certainly be much interested, and the result will probably be a great progress in our ideas concerning the propagation of waves, regardless as to what will be the final conclusion.

PARIS, FRANCE. ANDRÉ BLONDEL.

[A translation of the non-mathematical portion of the Angers paper to which Prof. Blondel refers is printed on page 41. The letter of Prof. Blondel was also accompanied by two reprints from the *Comptes Rendus,* one entitled "On Syntony in Wireless Telegraph" and the other, of which M. G. Dobkevith is joint author, entitled "On the Maximum Sensibility of Coherers Practically Used in Wireless Telegraphy." The first-mentioned refers to a communication deposited in the archives of the Academie des Sciences, August 16, 1898, in which a method of syntonization is proposed consisting in tuning the transmitting and receiving stations, not to the frequency of the oscillations proper of the antennæ, but two artificial frequencies much lower and entirely arbitrary and independent of the antennæ—namely, the frequency of the charges of the antennæ and that of a selective telephone, such as the monotelephone of M. Mercadier. A vacuum tube replaces the usual relay, and in shunt relation thereto is the telephone. In series with the latter is a battery of a strength not sufficient to break down the resistance of the vacuum tube, yet sufficient to produce a current at each passage of an oscillatory current in the tube. The telephone is thus affected at each emission of a signal from the receiving station, and the sound is determined by the number of charges per second given to the sending antenna. At short distances the vacuum tube can be dispensed with and the telephone placed in series with the receiving antenna. An advantage of this method is that the note of the sound in the telephone can be varied by varying the frequency of emission at the sending station, and by employing a telephone tuned to a given sound, selective telegraphy is possible. It suffices to maintain the frequency of the spark coil interrupter constant and equal to that of the receiver. The vacuum tube employed in the experiments was an ordinary Geissler tube having large electrodes almost in contact, but spontaneous decohering devices, such as the carbon coherers of Hughes, Tommasina and others may be used.

The theoretical interest of this method resides in its analogy with the synchronization of a pendulum by periodic shocks, which has been so ably investigated by M. Cornu. Each group of waves of high frequency, rapidly damped, acts *en bloc* as a simple percussion on a telephone diaphragm of slow vibration, which latter is sinusoidal owing to the effect of inertia. Consequently there should be no difficulty in applying at the receiving post the ingenious multiple telegraph arrangement of M. Mercadier. Finally, the principle of mechanical elasticity at the receiving station can be replaced by that of electrical elasticity, as follows: The detector may be mounted in series with the antenna or in shunt with a circuit containing a telephone, an inductance if necessary, and a battery shunted by a condenser. The capacity of the latter is fixed by the frequency of the charges of the sending antenna, so that the circuit is always in resonance, or rather, in pseudo-resonance, with the sending station; the signals will then be selected by any telephone, or to reinforce the effect, by a telephone tuned to the same frequency. The receiving circuits of different frequency can be connected to the terminals of the same tube, but it is preferable to have separate tubes and antennæ.

In this manner a station may communicate simultaneously with any number of other stations, and the different signals only be received by the respective stations tuned thereto.

The second paper relates to a method of increasing the sensitiveness of filings coherers by lowering the critical voltage of decoherence. Critical voltage is defined as the voltage which, applied continuously, prevents the tube from decohering quickly upon shock, its value for each coherer depending on the nature of the metal of the electrodes and of the filings and the degree of oxidation. The conditions to be fulfilled for maximum sensitiveness are that the battery e.m.f. be kept below the critical point; that the e.m.f. produced by the waves be greater than the critical e.m.f.; that to obviate deterioration the current established at the instant of coherence should be below a certain maximum—one milliampere in general; and that to decohere sharply, the current passing through the tube after a shock should be but a small fraction of the preceding current—that is, a small e.m.f. applied should produce a large relative variation of resistance. Thus the sensitiveness with a given antenna is increased by lowering as far as possible the critical value by the employment of filings only slightly oxidizable, and placing in circuit a battery of low e.m.f. and a relay of low internal resistance. We can then eliminate the supplementary resistance added in series with the relay to reduce the current, and thus raise to a maximum the relative variation of resistance produced in the cohering and decohering of the tube. The arrangement is still more perfect if instead of a battery a potentiometer across an accumulator cell is employed. The adjustment of the coherer may be made by changing the length of the column of filings by adding filings from a chamber connected to the tube, or vice versa, the effect being to vary the pressure between the various particles of filings.—EDS.]

DIGEST OF CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Single-Phase Motor.—CORSEPIUS.—An illustrated description of a single-phase motor without commutator, which starts under load. The author refers to the well-known property of the single-phase induction motor that it will not start by itself, but when once started continues to revolve and will give out power, and it makes no difference whether it is started in one or the other direction. The reason of this phenomenon is that the rotation of the motor causes a distinct change in the magnetic conditions; the apparent reluctance of any two portions of the stator winding is not the same, the difference being greatest when the two portions are displaced by one-half pole distance. The author, therefore, divides the stator winding into two equal portions, which are displaced from each other by 90°, in the same way as is usually done in single-phase motors. His motor, however, has two rotors, a main rotor, *a*, and an auxiliary rotor, *b*, shown in Fig. 1, in which *c* is the stator. The main rotor,

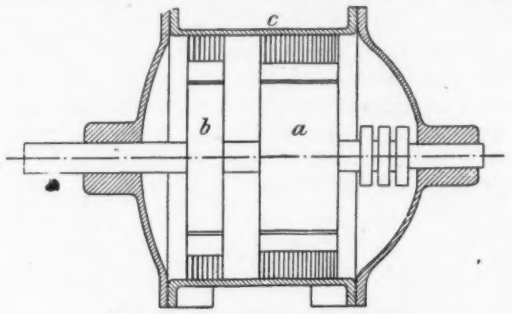


FIG. 1.—SINGLE-PHASE MOTOR.

a, is rigidly mounted on the shaft and its winding is connected with step rings, while the auxiliary rotor, *b*, is loosely placed on the shaft and is provided with a short-circuited winding. When the motor is started, *b* rotates without load and *a* starts then with torque. The auxiliary rotor, *b*, is provided to produce the change in the magnetic conditions, above referred to. To start the rotor, *b*, it is, of course, necessary to apply one of the usual starting devices; for instance, a small resistance. The author gives some data on a small experimental motor of this type, in which the stator part that surrounds the main rotor and the stator part that surrounds the auxiliary rotor are provided with their own individual windings; *e* and *f* in Fig. 2 are the windings surrounding the auxiliary rotor, *g* and *h* those surrounding the main rotor; *e* and *f* are first connected in series to the supply circuit, a small resistance being connected in parallel with *b*. The auxiliary rotor then starts. The small starting resistance is then removed, and the windings, *g* and *h*, are also connected to the supply circuit, whereby the points, *m* and *n* are connected with each other. It will be seen that this gives a network arrangement like the Wheatstone bridge; *g* and *h* are constant; *e* and *f* vary; hence an alternating current passes between *m* and *n*. The currents, *g* and *h*, are different at any moment, while their effective values can be equal. The currents, *g* and *h*, have, therefore, not the same phase. In the tests of the experimental motor the following results were obtained: The motor, when in operation, while giving 2.4, 4.62, 6.83, 7.95, 9.05 hp, took 48.5, 57.0, 68.4, 72.6, 78.4 amp., respectively. When starting under the same loads it took 48.0, 65.6, 86.2, 97.0, 97.0 amp.—*Elek. Zeit.*, December 10.

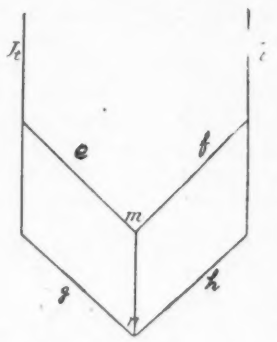


FIG. 2.—SINGLE-PHASE MOTOR.

Starting Torque of Three-Phase Motors with Variable Number of Poles.—BEHN-ESCHENBURG.—A communication on results of tests of two types of three-phase motors, built by the Oerlikon Company, with short-circuited armatures, for four speeds, obtained by a variation of the number of poles. The results for one machine are as follows: This is a 240-volt motor for a normal rating of 7 hp at 250 and 500 revolutions, and about 10 hp at 750 and 1,500 revolutions. The frequency is 50 and the weight 500 kg. The number of poles is 24 or 12 or 8 or 4; the starting current, 58, 60, 150, 116 amp., and the starting torque 25, 10, 18, 7.5 kg, respectively. For normal operation at 50 periods, the torque is 20, 10, 10, 5 kg, the speed 220, 470, 740, 1,470 revolutions, and the current 25, 19, 28, 25 amp.—*Elek. Zeit.*, December 3.

Design of Direct-Current Machines.—FYNN.—A continuation of his illustrated serial in which he says that the choice of winding rests between the form-wound coil and the hand-wound barrel winding, avoiding all soldered joints for any number of wires per slot per layer. Form-wound coils are only of distinct advantage in cases where the conditions of work are extremely severe and may cause a break-down within a few months from the start, however good the insulation and workmanship may be. He claims that a hand-wound armature is much less liable to a break-down than a formed coil. In the same issue he gives in a communication his reasons for advocating the rotation of the commutator opposite to the inclination of the brush.—Lond. *Elec. Rev.*, December 11.

Testing of Generators by Air Calorimetry.—An account of the discussion of Threfall's British institution paper which was recently abstracted in the Digest. Esson thinks that the method involves so many difficulties that it was rather a test of the ability of the experimenter than of the machine. Glazebrook gave some information on the use of the Pitot tube method for determining air pressures. Mordey was much interested in the method of measuring the air currents, since the measurement of the quantity of gas passing through very large pipes for the supply of very large gas engines may soon become very important, and Threfall's results with a Pitot tube show that greater confidence can be placed in this method than

appears at first sight. Threfall in his reply claimed that the method was not at all difficult, since anybody who can read a thermometer can apply it. A careless man will get a wrong result whatever method he uses. His method is, however, not a quick test, since one must wait until the temperature equilibrium is fixed, and in the case of his 3,000-kw alternator it took about six hours in order to obtain consistent results. There was some discussion concerning the increase from no load to full load of the iron losses or unascertainable losses. Esson contributed it to losses in the completely laminated poles of the generator. Mordey in other tests had found an enormous increase in these losses in machines with toothed armatures and in machines without laminated fields; that increase of losses was thus probably entirely due to the unequal distribution of the magnetism, to the toughening of the lines and the increase of eddies in the field and to the hysteresis of the armature itself.—Lond. *Elec.*, December 4.

REFERENCE.

German Dynamos.—GUILBERT.—The first part of what appears to become a very long and fully-illustrated serial on the construction of dynamos in Germany. The author gives details of the most typical machines exhibited at the Duesseldorf Exposition and discusses alternators. In the present installment a 2,000-kilovolt-amp. alternator of Lahmeyer and a 350-kilovolt-amp. alternator of Schorch are described.—*La Revue Tech.*, November 25.

LIGHTS AND LIGHTING.

Ionic Theory of the Electric Arc.—STARK.—An elaborate investigation applying the ionic theory to the phenomena in the electric arc. To simplify matters, the author starts from the mercury arc, which is longer than the carbon arc, and distinguishes four distinct parts, viz.: the brilliant brush issuing from the white hot depression in the cathode, the dark space, the positive light column and the anode layer. The glow discharge does not necessarily involve the evaporation of the cathode, but the arc light does. It is not essential that the anode should emit vapor. In all gaseous discharges one has to distinguish between electrons, positive atomic ions and molar ions. In the Bunsen flame negative electrons play a very prominent part. In the electric arc, with its higher temperature, they are even more predominant. This is shown by the susceptibility of the arc to magnetic deflection and the readiness with which it follows every variation in the current, owing to the great nobility of the electrons. The impact of the electrons produces positive and negative ions from neutral molecules at the anode and in the positive light. The converse only takes place in the glow discharge, whereas in the arc the negative electrons are produced from the cathode by electrification, and not from the gas by ionization. The ejection of electrons from the interior of the cathode is partly favored by the presence of ultraviolet light, but most of all by the high temperature of the cathode. This high temperature produces in the interior of the metal an electric force driving the electrons toward the anodes. Concerning the old question as to the counter e.m.f. of the arc, the author says that there is a counter e.m.f. in the arc when the anode is very hot and it represents the sum of the internal e.m.f. of the anode and cathode, but is much smaller than the minimum tension. The latter is not due to the counter e.m.f., but to the fact that a minimum of work must be done at the cathode in order to produce the radiation of negative electrons in sufficient density.—From *Ann. der Physik* No. 12; Lond. *Elec.*, December 4.

Photometric Tests of Street Lamps.—An abstract of a report by Bradley on tests of street illumination. The most interesting item seemed to be the comparative costs of candle-power per year, working out at 18.8 cents for the arc lamp and 18.24 cents for the Sugg high-pressure incandescent mantle lamp. It is pointed out, however, that the information is very scanty. While it is said that the tests on the gas lamp were taken at three different angles, these angles themselves are not given. Again, there is nothing to denote how long the mantles have been in use, and considering the variation in the illumination of the incandescent mantle, especially when used as street lamps, it is of importance whether the candle-powers are averages of periodic tests or to know to what conditions they refer. —Lond. *Elec.*, December 4.

POWER.

Hydroelectric Plants in Austria.—Some notes on recent developments. The municipal electric station of Innsbruck has recently been opened which gets its power from a hydraulic plant at the River Sill, 11 km. from the city. When completed, there will be six turbines, each of 2,500 hp, and coupled to a 10,000-volt alternator. In the main sub-station near Innsbruck the voltage is reduced to 2,000. The current will be used for lighting, power and traction. In Kruman, in Bohemia, the water power of the Moldan River has been utilized, 6,000 to 7,000 hp being available at the turbines. There are three 2,500-hp turbines, each coupled to a three-phase generator running at 420 r.p.m., and giving 2,500 kilovolt-amp. at a power factor of 0.7, the voltage being 15,000. The current is transmitted to two paper mills in which motors aggregating 2,000 hp are used. The voltage is reduced to 300 volts in the mills by three three-phase transformers aggregating 1,800 kilovolt-amp. The balance of the power is used for lighting and power purposes in towns in the neighborhood.—*Elek. Zeit.*, December 3.

Yorkshire Power Plant.—An illustrated description of the first of the four generating stations of the Yorkshire Electric Power Company. This plant is in course of erection and has a capacity of 6,000 kw. A three-phase system at a frequency of 50 cycles has been selected, the generating voltage being 10,000. There are four generating units, each consisting of the Curtis steam turbine and a 1,500-kw alternator. Each set is arranged with a vertical shaft with the generator above the steam turbine. The generator has six poles and is designed for normal full-load output of 1,500 kw with 100 per cent. power factor at a speed of 1,000 r.p.m. The full-load current is 86.5 amp. and the voltage between terminals 10,000. Three turbine sets, each of 150-kw capacity when running at 2,000 r.p.m., are provided for supplying power for excitation and auxiliary purposes. These turbines are of the Curtis type, arranged with a horizontal shaft. The voltage supply for excitation and power is 220 volts.—Lond. *Elec.*, December 4.

REFERENCES.

Water Powers in British Columbia.—JACOBS.—An illustrated description of some important hydroelectric plants in British Columbia. It is also pointed out that many important water powers are still unused, the development of which would promise good returns, for instance, in the Rivers Fraser, Columbia, Kootenay and Elk.—*Eng. Mag.*, December.

Niagara Falls.—BUCK.—A fully-illustrated description and statistical article on recent developments in Niagara power.—*Cassier's Mag.*, December.

Electric Power for Charging Metallurgical Furnaces.—KUEPPERS. —A detailed illustrated description of a crane, installed in a metallurgical plant in Russia, for discharging the various furnaces. For moving the crane as a whole and for its traversing movements electric power is used, while for lifting the blocks to be charged into the furnace hydraulic power is applied.—*Elek. Zeit.*, December 3.

Mechanical Stokers.—GAY.—An illustrated paper read before the (British) Society of Engineers in which the author gives a summary of the present situation of mechanical stokers for electric stations.—Lond. *Elec.*, December 11.

TRACTION.

Conversion of Cable to Electric Traction.—An illustrated description of the methods of conversion from cable to electric traction in St. Louis. The line upon which this change was made does a large business and it was considered necessary to make the change without interfering with the traffic. First a 9-in. girder rail for the electric road was set about 6 in. outside of the cable rail. The paving and the old cable slot rails were then removed. The tops of the cable yokes were broken off and a 6-in. rail for the electric track was mounted on the inside of the cable yoke. The old conduit was then filled in with broken stone. Temporary connections between the old and the new construction were made.—*St. R'y Jour.*, December 5.

REFERENCES.

Paris.—LETHEULE.—A very fully-illustrated description of the Metropolitan Railway of Paris.—*Eng. Mag.*, December.

Trolley Harp and Wheel.—A description of a new device, one feature of which is a guard placed before the wheel to permit the latter to slip under obstructions.—*St. R'y Jour.*, November 28.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Durban.—An illustrated description of the electric light and tramway system of Durban, which is a seaport of Natal in South Africa.

The traction plant consists of four 250-kw, 500 to 550-volt generators, while the lighting plant consists of three 350-kw and one 500-kw generators.—Lond. *Elec. Rev.*, December 11.

Exeter.—An illustrated description of the new electricity works at Exeter in which the two-phase system is used with three 400-kw and one 100-kw generators, the voltage being 2,200 per phase. There are two sub-stations.—Lond. *Elec.*, December 11.

REFERENCE.

Isolated Plants.—MOSES.—An article in which the author suggests organization and records for a moderate-sized isolated electric plant. —*Eng. Mag.*, December.

ELECTRO-PHYSICS AND MAGNETISM.

Permeability of Iron Powder and Iron Wire.—ZENNECK.—An experimental comparison of the change of the magnetic permeability of iron wire and iron powder in alternating fields. In an iron wire the permeability depends largely upon the frequency, and at a frequency of 1,000,000 per second it is about 1/10 to 1/30 of its normal value in a steady field. This is often explained by the supposition that at such high frequency the magnetization can no longer follow the field. This supposition seems, however, questionable, since a similar inability is not shown by iron powder (or at least to a much smaller degree), its permeability being nearly the same at a million periods per second, as it is in a steady field.—From *Ann. der Physik*, No. 12; Lond. *Elec.*, December 4.

ELECTRO-CHEMISTRY AND BATTERIES.

Electrolytic Oxygen and Hydrogen.—An illustrated description of the Schuckert system for the electrolysis of water. A cast-iron trough contains the electrolyte, which is a 20-per-cent. solution of potassium hydrate, and the iron electrodes, which are separated by strips of a good insulating material, extending from the top downward about three-fourths the depth of the cell. Between these separating plates and enclosing the electrodes are suspended iron bells which collect and carry off the developed gases.—*Electrochem. Ind.*, December.

REFERENCE.

Rôle of Formation Heats of Alloys in Electrolysis.—RICHARDS.—A theoretical note in which the author shows how to apply the numerical values of the formation heats of alloys in calculations of the e.m.f. corresponding to the dissolution of the alloy.—*Electrochem. Ind.*, December.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Recording and Analyzing Wave Forms of Alternating Currents.—HOSPITALIER.—A very long illustrated paper read before the (British) Institution of Electrical Engineers. After some brief introductory remarks on the methods of direct observation by the oscillograph of Blondel and Duddell and the rheograph of Abraham, he discusses at length the indirect stroboscopic methods to which he believes belongs the industrial future, since they have a wider field of application and permit of the direct recording of the phenomenon to be studied upon a strip of paper in the way that is not possible with the direct methods in which recourse is always had to photography. He describes briefly the following forms of stroboscopes, the arcoscope, the stroboscopic transmission dynamometer, the stroboscopic eye-glass and the differential stroboscope. He then describes in detail his ondograph, the object of which is to register directly upon a band of paper, by means of ink, the representative curves of periodically and rapidly varying electrical phenomena, such as e.m.f., current, power, etc. A synchronous single-phase alternating-current motor is actuated directly by the source of electrical energy of which the e.m.f. or current or power is to be recorded. A train of gearing is provided which imparts to a revolving commutator such an angular velocity that when the motor has made a certain number of revolutions, the commutator will have made an equal number, increased or diminished by one. In his commercial instruments a four-pole motor is used and when the motor has made $\frac{n}{2}$ revolutions, corresponding to n periods, the commutator has completed $\frac{n-1}{2}$ revolutions, with a regular and uniform retardation. The commutator consists of a cylindrical block of insulating material, carrying a tube of brass suitably cut to shape, with 3 brushes raised upon it (Fig. 3). The object is to put a condenser, *C*, successively in connection with, first, two points, *u* in the circuit in which the e.m.f. or current is to be recorded; secondly, the measuring apparatus, *E*. During the first operation the condenser, *C*, becomes charged, and is discharged through the measuring instrument, *E*, in the second. For recording the power curve the contact maker is reduced to a simple conducting bar, which, once in each revolution and by means of two brushes, closes the circuit through the fine-wire bobbin of the recording instrument. The condenser, *C*, may be regulated by means of plugs in order to regulate the sensitiveness of the apparatus. For differences of potential and current, the recording measuring instrument, *E*, is a moving coil instrument; for power curves it is an ordinary wattmeter. The main current passes continuously through the fixed primary bobbin, while the movable fine-wire bobbin is placed in the circuit which is periodically connected by the rotating commutator to the difference of potential which determines the second factor of the power. Regulation is effected by introducing resistance into the fine-wire circuit. In the commercial instrument the recording cylinder makes one complete revolution for every three periods recorded. Each of these three curves registered corresponds to 1,000 actual periods and 999 impulses. One complete period takes up a length of 4 in. on the cylinder. The ondograph allows the frequency of an alternating current to be determined with accuracy, since it is only necessary to determine by means of a chronometer the time occupied by the recording cylinder in making one complete revolution. As this time corresponds to 3,000 periods, this number divided by the duration of one complete revolution in seconds gives the frequency in periods per second. The recording apparatus comprises two distinct parts—the directing arm and the recording pen. The former is a rigid lever attached to the measuring apparatus, with the extremity the more remote from the axis of rotation terminating in a pin which works in a groove provided upon the lever carrying the pin. This pin, during the recording process, describes the path that would be taken by the pen of the ordinary recording instrument during the rotation of the cylinder carrying the paper. The recording pen consists of a lever of great length, so arranged that one of its extremities turns upon an axis parallel to that of the recording instrument, but removed from it by a distance approximately equal to the difference in the lengths of the two levers. The other extremity is provided with a groove engaging with the pin of the directing arm, and carries the recording pen at a point a little beyond the groove. In the commercial ondograph the directing arm is 7 in. long, while the lever carrying the pen is double this length. It will thus be understood that while the pin describes an arc of a circle with a short radius, the pen describes one of a long radius. By giving sufficient length to the lever the arc may, within the limits of the width of the cylinder, coincide sensibly with the tangent at the middle point of the arc. Thus, the point of contact of the pen with the paper is but very slightly removed from a generatrix of the cylinder, and the registration is effected with perfect regularity throughout the whole extent of the cylinder. The ondograph may also be used to study a rectified or continuous current. For this purpose the synchronous motor is replaced by a direct drive, effected by establishing an unyielding mechanical coupling between the ondograph and the shaft of the machine to be studied. In a new type of apparatus which he calls the differential ondograph permitting the retardation at will of the period recorded, it is easy to register phenomena occupying from 1/2000 to 1/3000 of a second, but this instrument is intended more for laboratory and research work than for industrial use. A great number of applications of the instrument is described and curves are reproduced showing distorted wave forms of currents from commercial alternators. In order to analyze an alternating-current wave form it is first necessary to determine the

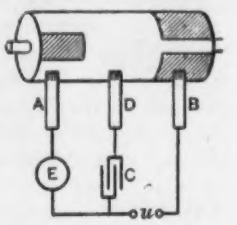


FIG. 3.—COMMUTATOR.

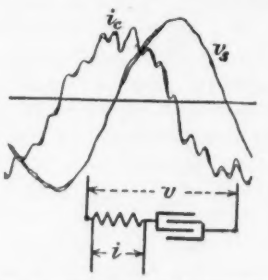


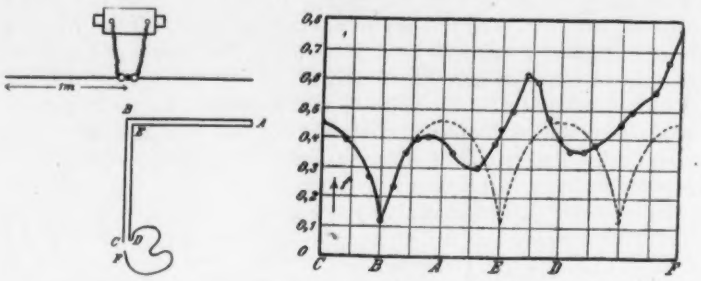
FIG. 4.—CURVE OF HARMONICS.

order of the highest harmonics present. This may be done in two different ways. In the first as large a capacity as possible is connected to the periodic potential difference to be analyzed and the curve of the charging current of the condenser is recorded by connecting the ondograph to the terminals of a non-inductive resistance included in the circuit through which flows the charging current of the condenser. This resistance should be as small as possible. By this method the nth harmonic is magnified in proportion to its order, n, and an indented curve is obtained in which the number of teeth indicates the order of the highest harmonic with the greatest clearness. Fig. 4 shows clearly the discovery of the 15th harmonics in the e.m.f. of a Paris supply current, a harmonic that the sinusoidal-looking potential difference would not have enabled one to predict. In the second method a circuit formed of a highly inductive coil, having as long a time constant as possible, and a non-inductive resistance, is connected to the terminals of the difference of potential to be analyzed. By using the ondograph to record the instantaneous values of the potential difference between the terminals of the self-induction, an indented curve is obtained analogous to that found by the other method. When the order n of the highest harmonic is once known, it is easy to trace the fundamental wave and all the harmonics with their several amplitudes, actual or enlarged in a given proportion, as well as their difference of phase relative to the curve under analysis. For this purpose he uses the method of Pupin, which consists in forming a resonating circuit for each of the harmonics.—Lond. *Elec.*, December 11.

Measuring Small Inductances.—STROUD AND OATES.—A description of an apparatus for measuring small inductances. The essential feature is the use of what is substantially an electrodynamometer with laminated iron cores, or it may be briefly described as a moveable coil D'Arsonval galvanometer in which the permanent magnet is replaced by an electromagnet, with a laminated iron core, actuated by a 100-volt alternating current. The solid iron core inside the moving coil of the ordinary D'Arsonval type, is in this instrument also replaced by a laminated one. The instrument is used just like an electrodynamometer when it is arranged for measuring the conductivity of electrolytes. The field magnet is placed across the mains and the highly-insulated movable coil is used to replace the galvanometer in the bridge. The key must be in the battery circuit and under no circumstances should it be in the galvanometer circuit. The apparatus may be used for measuring an inductance with certainty to something well under 1/10 of a millihenry. By adopting a specially sensitive arrangement the author succeeded in reading down to 2 microhenrys.—From *Phil. Mag.*, December; Lond. *Elec.*, December 11.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Multiplication Rod for Measuring Wireless Telegraphy Waves.—SLABY.—A long illustrated article in which he first describes the fundamental experiment on which his "multiplier" for wave measurements is based. Fig. 5 shows an oscillating system generating waves of a quarter wave length of one meter. The waves are received by the loop, $C\,B\,A\,D$, of a length of 4×1 meters. The investigation of the total loop with the spark micrometer gave the same voltage curves across for $A\,B\,C$ and $A\,E\,D$ with nodes at B and E and maximum amplitudes of oscillation at A and $C\,D$. The voltages at C and D were exactly equal and of the same phase. When a wire, $D\,F$, of two meter length (one-half wave length) is added, the voltage at the terminal, F, is much increased. If the wire, $D\,F$, is wound in form of a coil, a further appreciable increase of voltage is observed. Whenever a point of maximum oscillation of a conductor is connected with a coil of one-half wave length, the voltage at the free terminal of the latter is increased several times. This is why he calls such a coil a "voltage multiplier." He found later that the addition of such a coil and the form of its connection, as shown in Fig. 5, destroys the symmetry of the oscillation, the dotted line in Fig. 6 representing the symmetrical wave form and the full line, the voltages actually observed along the points, $C\,B\,A\,E\,D\,F$. Moreover, the greatest increase of voltage is observed at the terminal F if the length of the coil, $D\,F$, is not exactly a half wave length, but a little smaller. The author then gives some theoretical notes on the condition of resonance. Any earthed conductor of any form may be set into the condition of resonance if the point of the impressed oscillation equals 2π times the square root of the product of self-inductance and capacity of the conductor. This product, which is the deciding factor for resonance, is called by him "oscillation capacity." If it has the right value, there will be resonance whatever the value of the real electrostatic capacity may be. To produce a strong action into the distance, it is preferable to make the electrostatic capacity large; hence, the self-inductance small. On the other hand, for measuring waves, as for instance by the multiplier, it is preferable to make the electrostatic capacity small and the self-inductance large. For this reason the multiplier must be a wire wound in coil form. The wire will be the more suitable for this purpose, the smaller its diameter and the thinner the insulation; for the latter he has found silk insulation very good, but a very thin layer of cellulose-acetate to be still better. The coil is preferably wound on a glass rod which is provided at one end with a metallic coating. Direct-connection of the multiplier with the oscillating system under test, as in Fig. 5, is unsuitable on account of the distortion of the form shown in Fig. 6. The author has, however,



FIGS. 5 AND 6.—WIRELESS TELEGRAPH WAVE MULTIPLIER.

found that such a multiplier coil is brought into the condition of resonance by simply holding it near the oscillating system at a certain distance. The end of the multiplier, which is provided with a metallic coating, is held in one hand of the observer and thus artificially earthed; in the other hand one holds a short, thick earthed metal rod and moves this along the multiplier coil. At a certain position it will be observed that sparks appear at the free end of the multiplier rod; this indicates that the portion of the multiplier coil between its free end and the point where it is touched by the short, thick metal rod is set into vibrations corresponding to the condition of resonance. By artificial means the sparks can be made more easily visible. For practical use he has three multipliers, of 1, 2, 4 cm. diameter for measuring quarter wave lengths between 25 and 50, 50 and 100, 100 and 200 meters, respectively; the length of each rod is 80 cm., and the diameter of the silk-insulated copper wire 0.1 mm.—*Elek. Zeit.*, December 10.

REFERENCE.

Automatic Telephone Exchanges.—MERK.—A rather long communication on the disadvantages of the automatic telephone exchanges, reference being particularly made to an American system. He thinks the main point of inferiority, compared with ordinary exchanges, is the excessive use of an enormous amount of expensive apparatus. He believes that this is not necessarily involved in the design of automatic exchanges, and that in the arrangement of the latter it should be endeavored to approximate more the design of ordinary exchanges. In the automatic exchanges of the present day, the experience obtained in many years' practice in ordinary exchanges has not been taken advantage of.—*Elek. Zeit.*, December 3.

MISCELLANEOUS.

German Electrical Industries.—An article on new industrial amalgamations either completed or in progress, referring especially to the combination of the Allgem. Elek. Ges. and the Union Elek. Ges. The Austrian branch of the Siemens & Halske Company and the Austrian Schuckert Company will also combine. Another amalgamation is that of the Bitterfeld Electrochemical Company and the Rheinfelden Electrochemical Companies. The Berlin-Hagen Accumulator Works Company, which controls the Tudor type of storage battery in Germany, proposes to absorb the Pollak Accumulator Company, of Frankfort.—Lond. *Elec. Rev.*, December 11.

REFERENCE.

Training Apprentices.—DOWNTON.—An illustrated article in which, as an example of the methods of training apprentices in an engineering works, the system and methods of the Westinghouse Electric & Manufacturing Company are described.—*Eng. Mag.*, December.

New Books.

NOTES ON ELECTRIC RAILWAY ECONOMICS AND PRELIMINARY ENGINEERING. By W. C. Gotshall. vi + 252 pages; illustrated. New York, 1903. McGraw Publishing Company. Price, $2.

The electric railway art, while it is still undergoing radical and striking changes in its essential engineering, has long since emerged from the stage at which a writer in dealing with the subject finds it necessary to go back to the beginnings of history or to indulge in apologetics for explaining the rudiments. In other words, the broad principles of electric traction are as well established, although not so well understood, as those of steam traction; and what has been really required of late is a differentiation in the treatment of the theme. The motors, and the power plant, can be dealt with quite independently and regardless of each other, while neither is in any particular sense related to the engineering of the track and roadbed, or to the economics of the system as a whole. It is, of course, true that there is underlying these topics a deep and close relationship, but the man who would now deal with them all fully and adequately within the covers of one book must lay out a plan encyclopædic in its method and execution. A good deal of such work along the electrical engineering side has already been done, and one could cite standard books which can be studied with profit, and which are an absolute necessity to any engineer working in this field, but so far as we are aware, excepting perhaps an admirable earlier brochure by Mr. E. E. Higgins, there is nothing to compare with this masterly discussion by Mr. Gotshall.

The subject is not only novel but the point of view is also original, and the style of approaching the theme is really something different from what one has previously encountered in electrical literature. We do not know of anything quite the same in electric lighting, in its analogous treatment; and it would be well indeed if the now expanding field of telephony could be subjected to such keen and critical analysis, although some of the articles by Mr. Abbott in our pages have outlined economical considerations too often neglected in that department. Mr. Gotshall happily has looked at the subject first of all not simply as an electrical engineer enamored with armature windings and enthusiastic on rotaries, but as a civil engineer and also as a railroad builder whose broad range of vision compasses these subjects as a whole, and who while not neglectful of these very important points, relegates them to their proper place in determining not merely the style of equipment that is best for the road as seen from the viewpoint of electrotechnics, but that which is best and inevitable when the subject is studied by the banker, the promoter, and that ultimate beast of burden, the investor.

It is remarkable how many lines of study and topics Mr. Gotshall's exposition of the subject opens up. We have the field work not only in its relation to the physical contour of the country through which the road must pass, but the more subtle and more difficult surveys of a sociological character based upon the population tributary to the system, its wealth, its industries, its habits of travel and other data. Passing from these points in regard to cost of construction, the author deals with the operating expenses and the income, and in one valuable chapter the results furnished by existing systems are applied to other possible schedules and conditions. Human judgment is always liable to err, but a given set of facts applied to a given problem ought to work out pretty much the same all the time, and Mr. Gotshall's "template," if it may be so termed, is one to which anything at all corresponding can be fitted and tested. We imagine that Mr. Gotshall's remarks on the risk of employing the percentage of gross receipts method will surprise as well as instruct a good many people. In other chapters of the book also Mr. Gotshall deals with relative construction and operating data, and in a closing chapter the general principles laid down as to proposed installations and their permissible cost are illustrated by an assumed case which represents actual conditions.

In this connection it is well to premise that the keynote of the book is that struck by the modern development of high-speed interurban electric railroading. It would be a mistake to suppose for a moment that the ordinary street railway now limits the scope of electric railway work, and Mr. Gotshall has pushed his practical theorizing boldly into the new domain of interurban work where questions of high speed and low speed and their relative cost and yield are so pressing and so vital. Indeed, a book like this lies at the foundation of the change which is now going on, on short steam roads or short stretches of main lines from steam to electricity, and his analysis of the subject is as applicable to such work as it is to any new interurban road which it is proposed to make electric from the start. The book indeed concludes with a set of complete specifications for the construction of such an interurban system operating over its own right of way. In this field Mr. Gotshall, as those familiar with his career are aware, is peculiarly at home, and the reader realizes that he is being instructed by one who has studied his subject *au fond*.

A remark made at the beginning of this review is not to be misunderstood, for it should be added that the book embraces a great deal of intelligent discussion of such things as motor equipment, rolling stock, storage batteries, power plants, etc., but these are not treated as though they were the "whole thing," but are regarded in their proper place of subordination in a book whose theme is economics. A work of this kind is a good example of intellectual pioneership, which counts as much for the art as a whole as a radical new invention.

The Beginnings of an Industrial City.

Formerly the idea of a town springing up almost over night was entirely associated with the new West, and even now few know that in recent years staid old Western Pennsylvania has been the scene of some of the most notable examples of a Aladdin-like transformation of a countryside into a flourishing town or even city. Jeannette and Charleroi, each with a population now not far from 10,000, are examples of the Western Pennsylvanian method of systematic town founding, by which in the course of a few years farm land is covered with the streets and buildings of a thriving city.

The only likeness with Western town upbuilding is, however, in the element of magical growth. In a thickly settled section where the struggling limits of one town elbow those of neighboring towns, the conditions leading to the creation of new population centers are naturally different from those incident to homesteading. In Western Pennsylvania the making of a new town is purely the result of very definite industrial conditions. The expansion of an industry giving rise to congestion in its old district; increase of cost of living in large communities with its effect on the pay-roll; labor troubles, and above all, desirability of radical changes in manufacturing methods that necessitate the building of a new plant—these are some of the factors that have led to the remarkable town-founding movement in Western Pennsylvania. Yet another striking difference between the Eastern and Western new town is, with respect to its layout and the character of its buildings. Chance does not preside in the location of the different quarters with respect to each other, but the situation of the manufacturing, business and several classes of residential sections are carefully and definitely decided upon while crops are yet growing on the site; and the buildings instead of reflecting the crude ideas of new settlers are architecturally and in modern conveniences thoroughly up to date.

The latest example of one of these new towns is Trafford City, now well underway at what was formerly Stewart Station, about 17 miles east of Pittsburg, and which forms the latest contribution of Mr. George Westinghouse to the material wealth of the section of the country that owes so much of its industrial supremacy to his organizing genius.

The industrial conditions to which Trafford City owes its existence are the result of a situation brought about by the tremendous growth of the manufacturing operations of several of the great Westinghouse interests using foundry products in large quantity. To meet the demands, additions to foundry departments of works long ago ceased to suffice, and until recently the deficiency in castings was supplied from a number of foundries more or less distant from the works, one in fact being located in Cleveland, Ohio. Some months ago the industrial organization known collectively as the Westinghouse Companies, which includes among others the Westinghouse Electric & Manufacturing Company, the Westinghouse Air Brake Company, and the Westinghouse Machine Company, purchased through a subsidiary organization—the Westinghouse Foundry Company—600 acres of land in convenient proximity to the great factories of the Westinghouse Machine Company and Westinghouse Electric & Manufacturing Company, at East Pittsburg, all of which are now connected together and with Trafford City by a private railway of standard railroad gauge permitting the hauling of the heaviest loads that may ever require transportation.

In an article which appeared in these columns some weeks ago, the foundry plant was described in detail, and the present object is to deal more particularly with the town itself. In picturesque old European feudal towns, it is the castle on an eminence which dominates the landscape, the habitations of the retainers clustering beneath in humble array. At Trafford City the real dominating factor—the works—is unobtrusively located in apparent lowly subordination to the living quarters, which are ranged above on terraces giving an inviting prospect over surrounding valley and hill; and owing to the distance to the eastward of the Pittsburg manufacturing district, the atmosphere is free of the smoke which hangs over Pittsburg like a pall. Indeed, had one sought an ideal location for a suburban residence district his steps would have been halted at this spot.

Employers in the Pittsburg district have not been noted for displaying a yearning toward the domestic comfort of employees, as witness on every hand the rough-battened, unpainted houses, characteristic rather of a mining camp than of one of the oldest and, industrially, one of the richest sections of the United States. Mr. George Westinghouse has been an exception in this respect, and while indulging in no experiments toward the betterment of the conditions of the workman's life of the kind that has met with such dire results at Pullman and Dayton, he has ever been solicitous of the welfare of his employees. By these he wishes to be regarded as a friend, but in the manly sense, not as a condescending patron or misjudged as a doctrinaire looking on them as a class to be "elevated."

At Trafford City everything possible has been done that promised to conduce to the domestic comfort of employees, but done in such a manner that one with the most sensitive American spirit could find no cause to feel that he was being patronized or "elevated." The rents, and the prices of buildings offered for sale, are placed on the same basis as if the town were a commercial enterprise, with the difference, however, that the returns on the capital employed are fixed at a point corresponding to an investment in low interest-bearing securities; and the still further difference that owing to the building operations being on a great scale, the cost of houses has been a minimum, and when sold the figure is based on cost price.

The houses are of several different classes, intended to meet the means of any wage-earner, but in every case equal care appears to have been given to the architectural features. All houses are built of brick, and pleasing facades have been obtained by tasteful architectural design apparently involving little or no increased cost in construction. The architect has been particularly successful in the design of the blocks of buildings accommodating two families. A separate entrance at the ground floor for the second story is so skillfully worked into the design of the facade that the appearance of an apartment house is entirely suppressed. The interior layout in this case is no less successful, and the finish, while not expensive, is of a kind to appeal to the neat housewife. Yet the rent of these tasteful homes is even below that of a couple of rooms in a dingy, unhealthy city flat, ranging from but $10 to $12 per month.

Another class of dwellings consists of detached houses of two stories and finished attic, with pleasant yards. We were about to say that these are apparently intended for the more prosperous class of employees, but the rent charged—ranging in the neighborhood of $17 per month—is only about that paid by the average mechanic for vastly inferior quarters a few miles away in the city. In this case the occupant has the option of renting the house or purchasing it outright on the basis of a small payment monthly. Here again are apparent the advantages incident to building operations on a scale sufficient to justify the services of competent architects. There is an absence of the evident straining for effect so characteristic of American middle-class architecture, a light and home-like appearance being obtained by attention to proper proportions and a skillful handling of window and door details.

One of the interesting and the most original features of the town is Trafford Inn, which combines the functions of a hotel, bachelors' quarters and casino. The building is handsomely constructed of pressed brick with stone trimmings, and its interior arrangement is on the bachelor club plan. The Inn will serve as a home for well-to-do employees who have no families, and the charges are fixed at a sum just sufficient to meet expenses. In fact, the rates are such that a bachelor can here reside in dignified state for a sum little or no greater than that paid in a city for hall bedroom boarding house accommodations. On the first floor is a large reading-room, which can be joined to the large dining-room alongside to form a large hall for meetings and entertainments, and the basement is given up to a large billiard room and bowling alley.

The streets of the town are paved with brick and the sidewalks provided with flag stones. The plans for the town include a park system. Though but portions of the site are as yet occupied, what has already been done indicates that in due time a town will be reared on these terraced hills which will vie with the handsomest in the country, and be a Mecca for those who would study an interesting social and economic side of modern industrial development.

English Test of De Forest Wireless Telegraph System.

The British General Post-Office Department has recently tested the De Forest system between Holyhead and Howth, a distance of 64 miles, and using masts 180 ft., which were erected for wireless telegraph experiment two years ago. The De Forest apparatus was

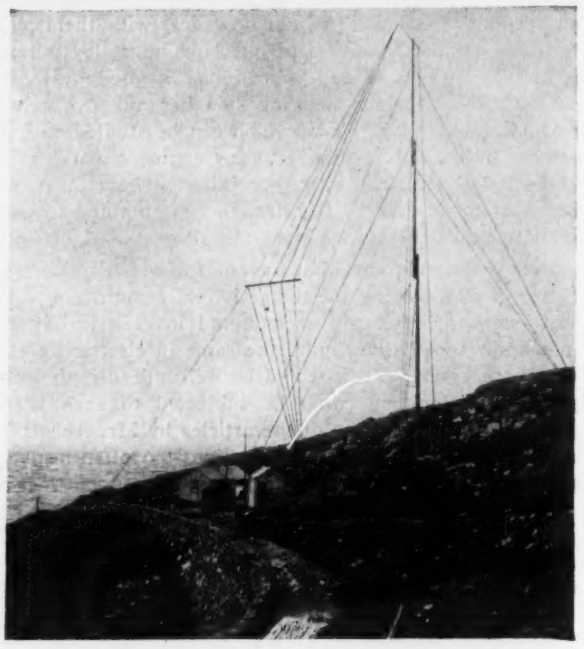


FIG. 1.—MAST AND ANTENNÆ.

installed at the invitation of the post-office officials, under direction of Dr. De Forest and W. M. Horton, his chief assistant, and has now been in successful operation for several weeks.

Power at both stations is furnished by small Fairbanks-Morse

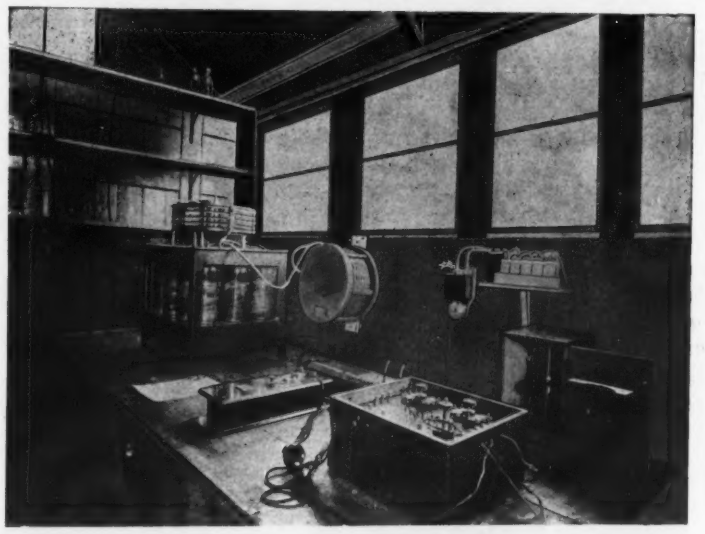


FIG. 2.—VIEW OF INTERIOR OF STATION.

gasolene engines, belted to a 1-kw, 60-cycle, 500-volt alternating-current generator. The transformers, condensers, tuning helixes, keys, etc., are, as in the standard De Forest apparatus; electrolytic responders are used and telephone receivers. A speed of 30 words per minute was attained during these tests.

At the invitation of Mr. Gavey and Mr. Lamb, secretary, the General Post-Office officials of the Netherlands Postal Telegraphs were present at the test of December 1, including Mr. De Braum, engineer-in-chief; Mr. Nerstrasz, assistant engineer, and Mr. Kiveron, technical adviser. Several of the officials themselves transmitted and received aerograms with the apparatus and expressed themselves as highly pleased with the facility with which the apparatus could be operated and the messages read.

Westinghouse Turbo-Electric Apparatus for Manila.

An important export order has just been closed with the Manila Construction Company, an American corporation conducting operations in the city of Manila, P. I., for a complete power equipment for the city traction system. The order was secured through Westinghouse, Church, Kerr & Co., and comprises the following machinery: Three 750-kw. Westinghouse turbo-generator units, two compound engine exciter units, one motor-driven exciter unit, three 500-kw. rotary converters, one 300-kw. rotary converter, four 250-kw. oil-insulated transformers, a complete switchboard, one series booster. This booster is mounted on the extended shaft of one of the rotary converters. The car equipments will comprise ninety double outfits of one Westinghouse type, and ten double outfits of another type using standard Westinghouse controllers.

The first turbo-generator unit will be delivered in about nine months. The turbine will operate at 150 lbs. steam, 26-inch to 27-inch vacuum, and 150 degs. superheat. It is fitted with the usual by-pass for securing an overload capacity of 50 per cent. It is also equipped with a quick-closing throttle valve. The turbo-generators will furnish three-phase, 60-cycle current at 380 volts; part of the current will be converted to direct current by the power house railway substation, and the remainder will go to transformers for supplying the high-tension distributing system. The transformers are oil cooled and connected in the two-phase, three-phase, or Scott system for three-phase transmission. The turbine machinery will also furnish current to the local light and power system.

German Three-Phase Transformers.

In the industrial development of polyphase systems in this country it has been customary until recently to provide a single-phase transformer for each phase whenever voltage transformation was required, while on the other hand it has been the custom abroad to install polyphase transformers. The Allgemeine Electricitäts Gesellschaft, of Berlin, which, with its chief engineer, Mr. von Dolivo-Dobrowolsky, has done important pioneer work in the development of three-phase alternating-current engineering in Germany, has built three-phase transformers for many years. A brief description of

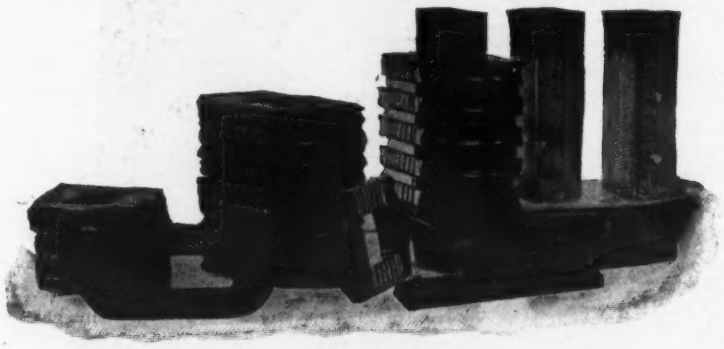


FIG. 1.—PARTS OF TRANSFORMER.

the latest types of oil-cooled, three-phase transformers built by this company will, therefore, be of interest.

All these transformers of capacities between 1 and 50 kw are oil-cooled, since it has been found that a much more compact construction can thus be obtained than with air cooling; other things being equal, an oil-cooled transformer has a higher efficiency and a smaller voltage drop than an air-cooled transformer of the same dimensions. Moreover, since oil prevents the windings from coming into contact with air, there is no danger of oxidation. This is a point which does not seem to be sufficiently appreciated by electrical engineers in general. In a Franklin Institute paper of Mr. C. E.

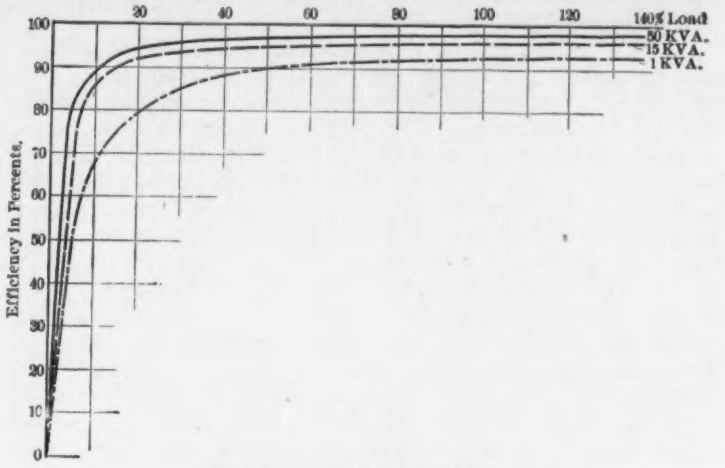


FIG. 2.—EFFICIENCY CURVES.

Farrington on the chemical problems involved in the production of a perfect insulating material for electric machinery, the author points out that while electricians like to claim that their apparatus is well ventilated, they forget that "well-ventilated" also means well oxidized.

All these transformers are built as core transformers with the three cores in one plane. The cores are made up of thin iron sheets covered with paper. As few bolts as possible are used passing through the laminations, and the number of accessory cast-iron parts is restricted as far as possible in order to reduce the losses due to eddy currents, etc., to a minimum. Fig. 1 shows the method of building up the transformer.

The smaller sizes (up to 7 or 12 kilovolt-amperes) and for voltages up to 6,000 on the high-tension side, have concentric windings, the high-voltage winding being at the outside. In the larger sizes the windings are subdivided into smaller coils, the high-tension and low-tension coils being placed alternately side by side on the core. The transformers for 10,000 volts on the high-tension side are built altogether with concentric windings, but the outside high-tension winding is subdivided into a number of smaller coils. As insulating material specially prepared paper is used with a thickness of 0.1 to

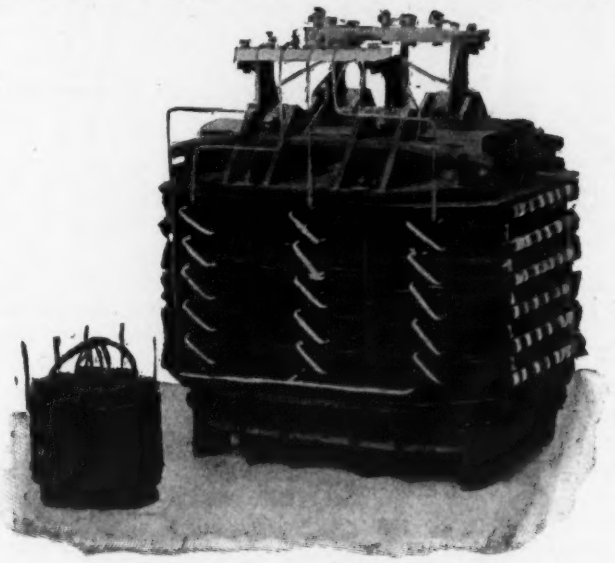


FIG. 3.—METHOD OF BUILDING UP.

0.5 mm., several layers being placed above each other. A thickness of about 0.2 mm. stands 8,000 to 9,000 volts.

The increase of temperature, guaranteed for continuous operation, is 40 to 45° C. in the oil at the top. In general it takes about 15 hours of continuous operation until the maximum temperature is attained. The temperatures of the copper are at the highest 8 to 10 per cent., those of the iron about 5 per cent.

There are three different types of A.E.G. polyphase transformers, namely, for use up to 6,000 volts and for 1 to 50 kilovolt-amperes (type A.D.O.) up to 3,000 volts and for 1 to 52 kilovolt-amperes

(type B.D.O.; and up to 10,000 volts for 5 to 50 kilovolt-amperes (type C.D.O.). A diagram giving the efficiency of the first-mentioned type of transformers of three different sizes, as function of the load, is given in Fig. 2.

TYPE ADO.

Primary voltage.	Secondary voltage.	Capacity in kilovolt-amperes.	Efficiency in per cent at full load, $\cos \phi = 1$.	Voltage drop in per cent at full load, $\cos \phi = 1$.	Iron losses in per cent.	Weight in ky of the complete transformer with oil.
2000	250 to 50	1	92.5	3.3	4.8	160
3000 to 4000	250 to 50	1	91.2	4.0	5.5	160
2000	250 to 50	5	95	2.8	2.4	285
3000 to 4000	250 to 50	5	94.8	2.9	2.6	285
6000	250 to 50	5	94.4	3.2	2.7	285
2000	550 to 50	10	96	2.3	1.8	420
3000 to 4000	550 to 50	10	95.6	2.5	2.0	420
6000	550 to 50	10	95.4	2.6	2.2	450
2000	550 to 100	20	96.7	1.9	1.5	610
3000 to 4000	550 to 100	20	96.4	2.2	1.6	650
6000	550 to 100	20	96.2	2.2	1.6	650
2000	550 to 100	50	97.2	1.5	1.1	1240
3000 to 4000	550 to 100	50	97.2	1.5	1.2	1270
6000	550 to 100	50	97	1.6	1.3	1270

TYPE BDO.

Primary voltage.	Secondary voltage.	Capacity in kilovolt-amperes.	Efficiency in per cent at full load, $\cos \phi = 1$.	Voltage drop in per cent at full load, $\cos \phi = 1$.	Iron losses in per cent.	Weight in ky of the complete transformer with oil.
3000	550 to 50	9	95.4	2.6	2.3	340
3000	550 to 100	52	97.2	1.6	1.2	1270

TYPE CDO.

Primary voltage.	Secondary voltage.	Capacity in kilovolt-amperes.	Efficiency in per cent at full load, $\cos \phi = 1$.	Voltage drop in per cent at full load, $\cos \phi = 1$.	Iron losses in per cent.	Weight in ky of the complete transformer with oil.
10,000	550 to 100	10	94.75	2.4	3.15	435
10,000	550 to 100	50	96.9	1.7	1.55	1390

The above tables give details of the behavior of the three different types.

High Potential Switches.

Fig. 1 is a view of a three-pole, double-break oil switch designed and made by the Hartman Circuit-Breaker Company, of Hansfield, Ohio, for installing on the back of a panel, and to be used on circuits up to 11,000 volts. The view shows the switches in the "off" position with one of the switches enclosed in an oil tank. Each pole of the switch is immersed in a separate tank, which is entirely independent of the adjacent ones and can be readily removed without in any way interfering with the adjacent others. The tanks are lined with insulating material, which is formed in such a way that there is just sufficient space for the free vertical movement of the switches, and the quantity of oil used is thus reduced to the minimum.

A feature of this oil switch consists in the use of the laminated or brush form of contact, which greatly increases the current-carrying efficiency of the switch and also entirely prevents "freezing" or sticking at critical periods. These contacts are protected by final arcing plates, which, with the corresponding plates on the terminal blocks, are removable and can be readily replaced should they become burned away in the course of time. The form of contact which is used and the isolation of the switches in separate compartments gives the switch a very large breaking capacity.

The movable parts of the switch are controlled by means of specially-treated wooden rods, which are fastened at their upper ends to a common cross-bar. They are held in normal position by means of a toggle lock. The switch is opened by giving the handle a slight turn in the direction opposite to that taken in closing. This will cause the toggle to move past the center and the switches will then open free of the controlling handle, thereby producing an absolutely quick break.

In Fig. 2 the switch is shown with automatic overload attachment. There are usually two tripping coils provided for a three-pole breaker, but it can be constructed with a tripping coil in each line. In all cases the operation of any one tripping coil will break all lines.

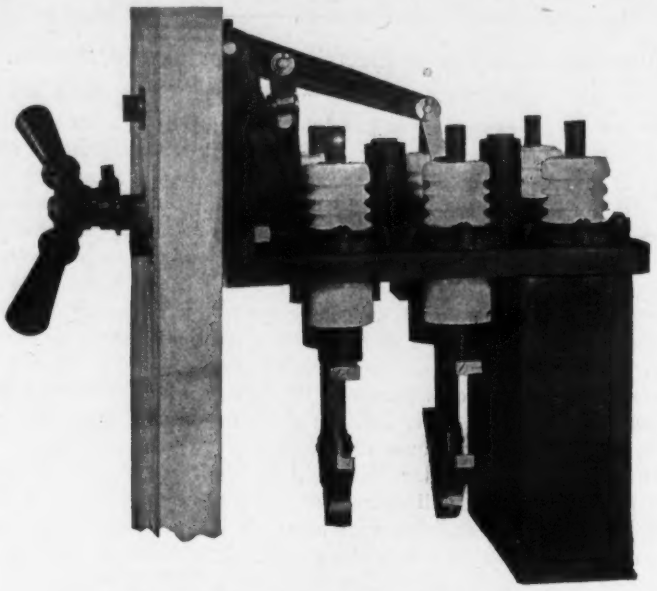


FIG. 1.—THREE-POLE, DOUBLE-BREAK OIL SWITCH.

The distinctive feature of this overload attachment lies in the fact that the tripping coils are energized by current from the high-potential circuit, and the use of series transformers in connection with the circuit-breaker is entirely avoided. The tripping coils, instead of being located on the front of the panel, as is commonly the case, are mounted by means of special porcelain insulators on the

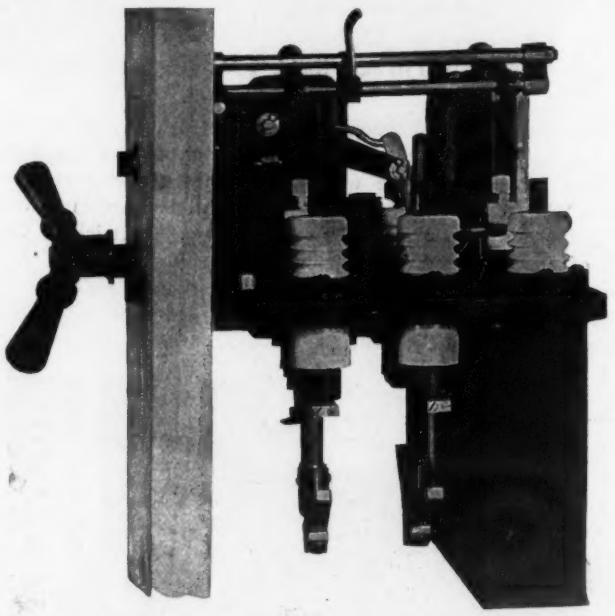


FIG. 2.—AUTOMATIC OVERLOAD ATTACHMENT.

carrying frame itself. They are separated from each other by barriers of insulating material, and the method of insulation throughout is of the highest order. The overload attachment has other distinctive features, one of the most important of which is that it cannot be held closed while an overload exists on any line.

This apparatus is also constructed with remote electrical control, to be installed apart from the switchboard and to be opened and closed from a distance. The operating current may be derived from the exciters, a storage battery or any convenient source of direct-current supply at from 110 to 500 volts. The remote control attachment is said to be very reliable and to add but little to the cost of the installation.

Alternating-Current Signals on Electric Roads.

An interesting system of automatic block signals has been perfected and brought forward by Mr. S. Marsh Young through the Pneumatic Signal Company, of Rochester, N. Y., which is now introducing the invention. Mr. Young, who is well known to our readers, has worked out carefully a method, the details of which are given below, and which have been studied by one of our staff under conditions of actual operation.

The essential features of this system are: 1. The use of alternating current for signaling, and the employment of the traffic rails for the signal circuit as well as for the return power circuit. 2. The use of a special bond for connecting the sections of adjacent blocks around the insulated joints, and also cross-connecting the tracks, which offers little resistance to the direct current, but effectually chokes back the alternating currents. 3. The use of special relays at the entrance of every block, which control the operation of the signals. Fig. 1 shows the arrangement of the apparatus as employed in the demonstration last week. By reference to the cut it will be seen that *X* represents the block rail, *Y* the common rail, *L* the alternating-current transmission line conveying power from *A C*, the alternating-current generator at the station, to the signaling apparatus on the line. The signal blocks are represented in their order as 1, 2 and 3. *T* is the transformer furnishing current for the track circuit to block No. 1, and *T'* performs the same service at block No. 2. *R* and *R'*, respectively, are the relays governing signals *S* and *S'*, while *I J* indicate the insulated joints in the block rail, around which the special bond is utilized, and B_1 and B_2 are similar bonds, which make the block rail

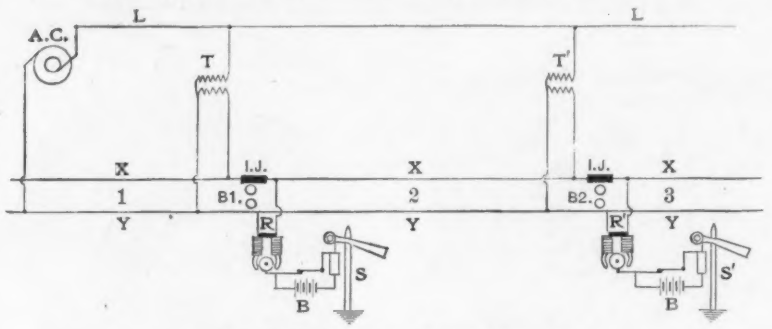


FIG. 1.—DIAGRAM OF TRACK CONNECTIONS.

(*X*) electrically continuous. Fig. 2 shows that portion of the signal mast carrying the case containing the operating mechanism, which can be readily understood. The door of the case is represented open in the cut, thus exposing the mechanism to view. It should be mentioned in this connection that the operation of the system is not limited to the use of this type of apparatus. The operating mechanism consists principally of an electric motor with a train of gear wheels, and an electrical control for making and breaking the connection between the motor and the blades. The motor is entirely enclosed, the commutator end having a glass shield. The power is transmitted through a train of gear wheels.

The principle upon which this system is based is that while it is impossible to keep two direct currents of different potentials separate on the same conductors, an alternating current may be introduced to perform one of two given functions, and if proper apparatus is supplied to keep each current from interfering with the instruments designed to be operated by the other current, the track circuit becomes feasible and practicable. The apparatus must, of course, become operative only under the influence of one current, and must remain inoperative in the presence of any other current, and while it may be called upon to afford a path to the direct current, it must effectively choke back the passage of the alternating current. By this arrangement one current may be used to operate the car, and the other to operate a track circuit to control the signals without interference or interruption.

On a direct-current road, an alternating current is impressed on the direct-current line for signaling, and a road employing alternating current may also be operated if the power current and the signal current have different characteristics. In the test the road employed direct current at 500 volts, and the signaling circuit carried alternating current at 300 volts, which was reduced at the transformers to 3 volts.

In the main power station and in each substation a small alternating-current generator should be placed to provide this alternating current, and in the experimental work on the Sodus Bay Railway a motor-generator was employed. As each block only requires about 20 watts for track circuit purposes, a double-track road, 15 miles in length, with 1-mile blocks, would only require a 1-kw. machine. A No. 10 wire is carried along the entire length of the road for furnishing the alternating current to the signaling system.

It has already been mentioned and shown in the diagram how the divided traffic rail is made continuous electrically as a return path to the direct-current generator, and the other traffic rail is uninterrupted. The track is divided into blocks as it is on steam roads, although but one of the traffic rails is broken for block signaling purposes. The other rail is used as a return for both direct current and alternating current. To one end of each block is fed alternating current transformed to the proper voltage, and at the other end of the block the relay is connected across the two track rails. Between the relay and the track is interposed one of the special bonds, preventing the relay from being affected by the direct current. Between the ends of adjacent block sections are also placed bonds, which offer a free path for the direct current to return to the station, but effectively choke back the alternating current and likewise prevent its escape into adjacent blocks, thus making the operation of the signals in each block independent. While the two traffic

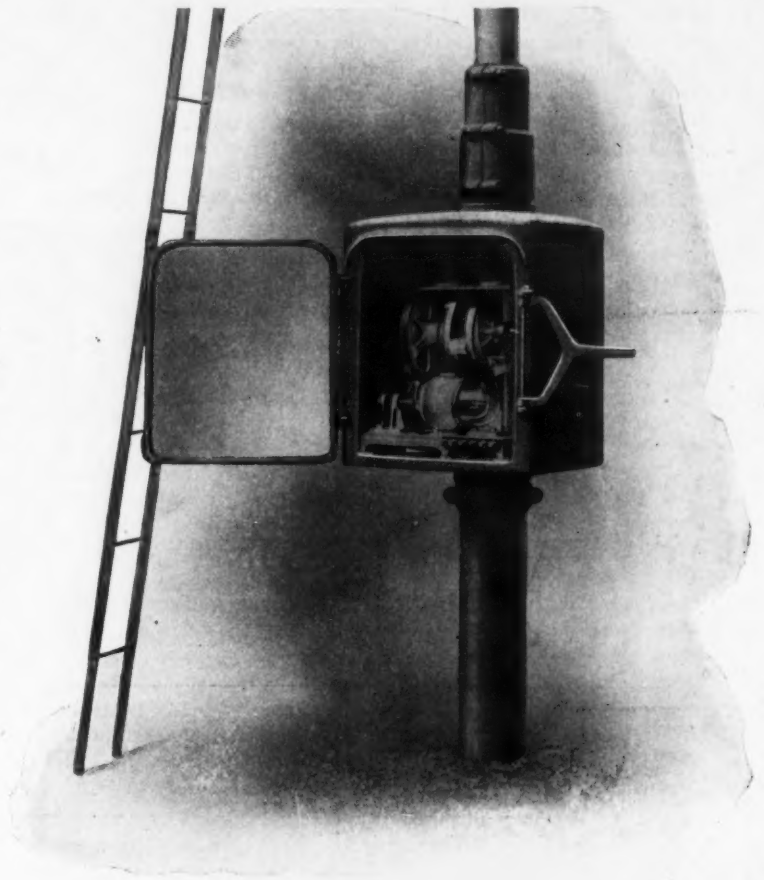


FIG. 2.—OPERATING MECHANISM.

rails are of the same direct-current potential, there is maintained between them a difference of alternating-current potential for the operation of the track circuit of the signal system, but this does not interfere with the operation of the motor circuits. Cross-bonding between the traffic rails or between the block rail and the feeder return is accomplished by the use of devices similar to those used across the ends of the blocks.

In the Rochester exhibition the road was divided into two blocks, one of about half a mile in length controlling the operation of the signals shown, and the other a short block to show that there was no interference between blocks, and that the direct-current return was made continuous through both rails of these blocks.

In the station the motor-generator was operated from a 500-volt trolley circuit, and generated a 300-volt alternating current of 100 cycles. The number of cycles employed was determined by practical considerations wholly, the adoption of this particular standard, for instance, being occasioned by the desire to strike a mean between the ordinary lighting circuit as well as to prevent synchronism be-

tween the current-operating signal apparatus and that which will probably be used on the roads employing alternating-current motors.

A No. 10 copper wire runs the entire length of the road, and feeds the primaries of transformers located at the farther end of each block. These transformers are of 100 to 1 ratio, and the secondaries are connected directly across the rails, which sets up a difference of potential between the rails of about 3 volts. The secondaries of these transformers practically take the place of a primary battery on the steam railroad track circuit.

At the entrance to the block was shown one of the relays of special construction, which are only susceptible to the action of alternating current of a proper frequency, while current of different frequency does not affect it. The relay is also independent of any difference of track-current potential that may exist between the rails.

In the demonstration, as has been mentioned, one rail was uninterrupted through the entire length of the road, the other being divided up into blocks corresponding to the signal locations, and insulated by means of standard insulated joints, the same as are employed in steam railroad work. Up to this point the system would present an insulated rail for signaling purposes, owing to the insulated joint between the sections, but this divided rail is made continuous electrically by means of the bond, which is one of the essential features of this system. This bond bridges the insulated joint, and its design and construction are such that while it presents a perfectly free passage for the direct current around the joint it chokes back the alternating current, and thus keeps each block perfectly independent. Similar bonds are placed across the traffic rails in each block.

The signal shown was of the electric motor semaphore type, and operated from the 500-volt trolley line. The resistance, consisting of five incandescent lamps, was interposed between the line and a storage battery of six cells. These lamps were utilized to illuminate the blade, and the storage battery performed the double function of operating as a reserve in case the trolley circuit was cut off, and also enabling the signal circuit to be broken between the points of the relay. The electric motor operated at 12 volts, and took 5 amperes for 5 seconds to pull down the semaphore arm. It was held down by means of a mechanical clutch, taking about .02 of an ampere.

One of the features of the system shown was that even after the insulated joints between the blocks were broken down by a special arrangement, making the polarity of adjacent blocks opposite, the current from one block would rotate the relay in the direction opposite to that which it which normally take, upon the signal circuit, and produce a danger signal. This relay is in reality an alternating-current motor without brushes. Its armature is connected to traffic rails, and its field is energized from the same source of alternating current. It will thus be seen that a car, entering the block and short-circuiting the secondary of a transformer supplying current for that block, will cut off the current of the armature, and thereby cause it to assume its normal position, which opens the local signal circuit.

In operation it was shown that where there was no car in the block the track circuit was completed from the secondary of the transformers through one rail, through the relay and over the other rail back to the transformer. This circuit, when completed, holds the relay points closed, and closes the local signal circuit, which holds the signal to clear. The entrance of a car into a block short circuits the transformer, thereby de-energizing the relay and opening the signal circuit, causing the signal to go to danger. Any interruption to the track circuit from any cause will rob the relay of its current and will result in a danger signal.

It has been the aim of the inventor to have the system so arranged that no possible combination or failure of parts can produce a clear signal when a danger signal should be shown. For instance, the breaking down of the insulated joints between the blocks will result in the giving of a danger signal, and direct-current from any foreign source cannot affect operation, while the presence of stray alternating currents will also fail to operate the relay.

Where electric motor semaphore signals are used, six small cells of storage battery are connected through a resistance to operate the signal motor. The battery also provides a reserve which will operate the signals while the motor current may be off. The battery is charged with about ¼ ampere continuously.

"Ideal" Universal Motors.

The type of direct-current motor illustrated herewith, manufactured by the Ideal Electric and Manufacturing Company, Mansfield, Ohio, is made in sizes ranging from 2 to 35 hp, and in three styles—open, semi-enclosed and inclosed. They can be used for belting, coupling or gearing to the driven machine or shaft, and mounted on the wall, floor or ceiling; the mounting, moreover, can also be changed at the convenience of the user.

The armature core discs are made of very thin armature sheets,

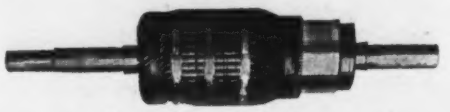
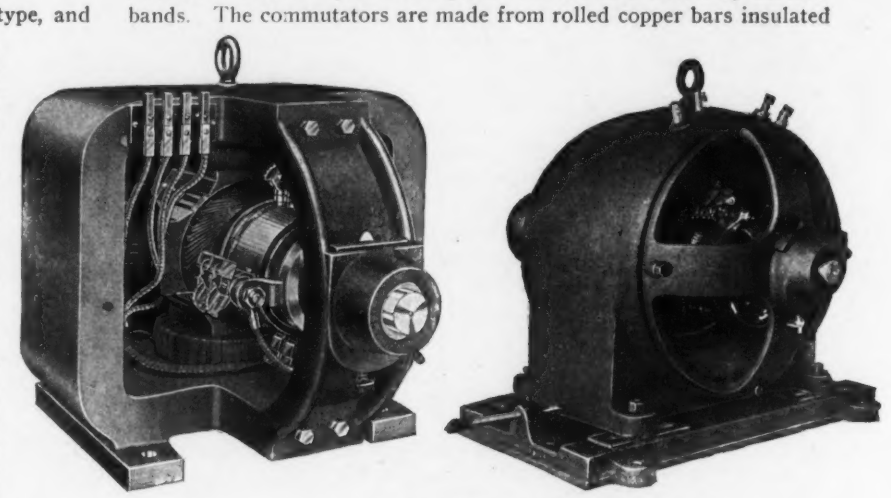


FIG. 1.—ARMATURE.

reannealed after being punched, and then coated with an insulating compound. They are built up directly on the shaft and provided with ventilating openings parallel to the shaft through which air can pass to ventilating ducts between the discs and outer ribbed flange, thus providing thorough ventilation through the entire core and windings. The winding consists of form-wound coils, the smaller armatures being wound with round wire and the larger ones with flat copper strip; the coils are independently insulated, dipped in a special insulating compound and thoroughly baked before being put in place on the armature core, where they are retained in the slots by surface bands. The commutators are made from rolled copper bars insulated



FIGS. 2 AND 3.—UNIVERSAL MOTORS.

from each other by the best grade of amber mica segments. The segments are of unusual length and depth, allowing an ample margin for wear and insuring cool and sparkless commutation. The flanges are of cast iron, insulated from the segments with solid V rings. The commutators are easily removed from the armature shaft.

Exceptional care has been used in the design of the mechanical features, as rigid construction is an important factor in the satisfactory performance of this part of the machine. The brush holders are clamped on the stems close up to the point of brush contact, the brushes being of composition graphite and carbon, and fed toward the commutator through a milled trough in the face of the holder. The brushes are held firmly against the face plate by means of a flat phosphor-bronze spring, brush tension being provided by means of a finger actuated by an adjustable spring. The holder is very simple in design, aside from being reliable in its operation. The brushes operate without vibration, and the machines are practically noiseless in service. The brushes can be readily and independently adjusted, and any brush can be quickly removed while the motor is in operation. The brush contact area is in all cases ample, the current density being at the minimum consistent with economical design. After the brushes are properly set no shifting is required and the motor operates without noise or sparking. The machines are designed to operate at their full rated capacities without the temperature of the armature or field windings rising more than 30° C. and to operate at an overload of 25 per cent, for a period of two hours, and 50 per cent overload for two to three minutes without injurious heating or sparking.

High Power Westinghouse-Parsons Steam Turbines.

The Westinghouse-Parsons steam turbine was commercially introduced in this country several years ago, the sizes then built being of 600 hp nominal capacity, direct-connected to 400-kw, polyphase generators. Subsequent development has been so rapid that within a period of four years turbines of 5,500 kw, or 7,500 hp, nominal capacity, have been designed and are under construction. These machines will have a continuous overload capacity of 11,000 hp, in one self-contained unit, and thus rank among the world's largest prime-movers. Recently marine work has been contemplated by the builders and the near future may be productive of turbines of still greater power, although of slightly different arrangement necessary to adapt the present type to marine usage.

The 5,000-kw turbo-generating unit illustrated herewith is representative of the general type which will be constructed for large powers. This type embodies the experience acquired in the construction and operation of a large number of machines. The principle of operation as well as the general relation and arrangement of rotating and stationary elements characteristic of former types has been employed. The largest machines, therefore, find their direct prototypes in the original design adopted, thus in a measure vindicating the wisdom of adherence to the design of maximum simplicity, viz.: the horizontal single-cylinder turbine.

The most distinguishing features of the new type are the extreme compactness and low speed secured. These features have been practically prescribed by the necessity of minimizing the cost of power building construction for larger station capacities.

The space occupied by the 7,500-hp turbine is approximately 27 ft. 8 in. by 13 ft. 3 in., and the height to the top of the hand railing is 12 ft. This is equivalent to .049 sq. ft. (less than one-twentieth sq. ft.) per electric horse-power capacity, or 20.2 hp per sq. ft. of floor area required. For the complete unit a rectangular area of 47 ft. 4 in. in length and 13 ft. in width is required, which is equivalent to .084 sq. ft. per electrical hp-capacity, or 12 electrical hp per sq. ft. of floor space.

A graphical comparison of floor space required for different types of prime-movers is shown in Fig. 2. In all cases a complete unit is taken as the basis of comparison. This point of relative economy of space is well illustrated by Fig. 3, which represents, in plan, the comparative space occupied by the 5,000-kw Manhattan Railway (New York) engine type units and the 5,000-kw Westinghouse-Parsons turbine units.

In point of speed, the new type fulfils the demand for a unit operating at moderate speed. The 3,000-kw units operate at 750 r.p.m., the 2,000-kw unit at 1,200 to 1,560 r.p.m., and the 1,000-kw unit at 1,500 to 1,800 r.p.m., depending upon the frequency desired. These speeds, although not comparable to engine speeds, do not impose much greater stresses upon the rotating parts, and in addition secure the great advantage of reduction in the bulk, weight and cost of the unit.

The accompanying plan and elevation of the 5,000-kw unit shows the general arrangement of the main cylinder body, bearings and auxiliary parts. The unit rests upon a single bedplate cast in two sections, secured by shrunk links. To the bedplate, which is heavily ribbed to secure rigidity, are bolted the pedestals, generator casing and turbine body, but the bedplate itself is not secured to the foundation by other means than the weight of the unit. Steam and exhaust connections are made beneath the floor level.

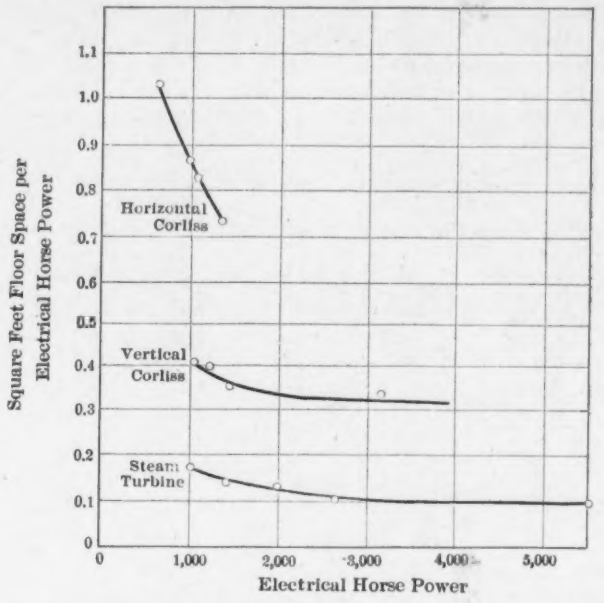


FIG. 2.—COMPARATIVE FLOOR SPACE OCCUPIED BY PRIME-MOVERS.

In the smaller machines of this type the cylinder barrel and both journals are cast in a single casting, thus largely minimizing machine work. In the large machine, however, the barrel is cast in two sections united by links, the outboard section carrying the journal and worm casing, and the inboard section the journal and exhaust opening which extends through the bedplate. As in former types, linear expansion and contraction of the turbine are provided for by a sliding foot. The inboard journal pedestal is bolted securely to the bedplate, but the outboard pedestal is free to slide between parallel machined ways. The main body of the casing is heavily lagged with non-conducting material, secured in place by sheet steel casings.

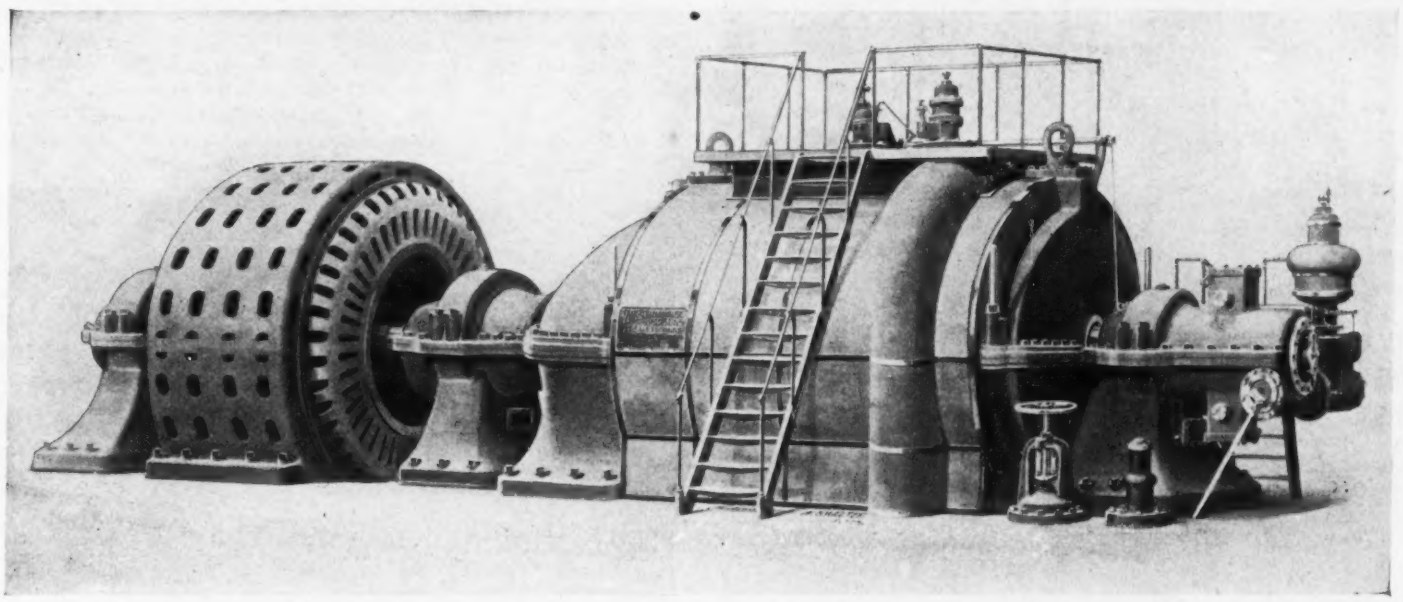


FIG. 1.—5,000-HP STEAM TURBINE.

Leakage of air from the atmosphere into the exhaust spaces of the casing at the entrances of the shaft is prevented by frictionless packing glands. No oil is employed and in consequence the condensation from the turbines is pure distilled water.

In shaft construction great rigidity has been secured with minimum use of metal. A central steel quill carries the entire rotating parts, both blades and balance pistons. Hollow forged steel ends are

forced into the two ends of this quill under hydraulic pressure, and are, in addition, secured by arrowhead links. High-pressure steam is conveyed to all parts of this quill structure in such a manner as to eliminate stresses and consequent distortion due to highly superheated steam.

Power is transmitted to the generator shaft through a flexible coupling which is housed partly by the turbine and partly by the generator inboard journal. The coupling is split at the junction of the two shafts, so that by removing one bearing cap and the coupling bolts, either section of the unit may be lifted out without disturbing the adjustment of the remaining section. In the smaller sizes the engagement surfaces of the coupling consist of the squared or hexa-

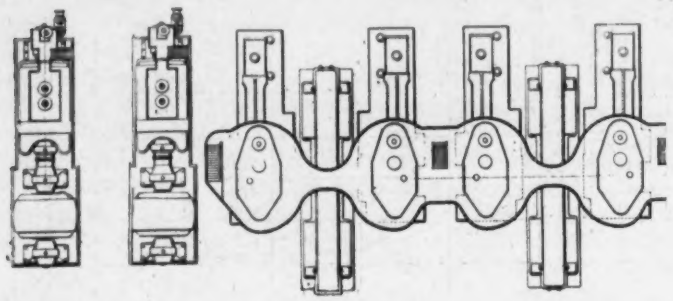


FIG. 3.—COMPARATIVE SIZES OF TWO TURBINES AND TWO RECIPROCATING ENGINES.

gonal ends of the shafts, but in the larger machines a crow-foot sleeve is keyed to each shaft and the power is transmitted by an outside quill engaging the crow-feet. Thus great flexibility is secured, together with the greatest facility in dismantling.

The journals in the larger machines are of the solid self-aligning type, similar to that employed in generators and cross-compound engines. The departure from the familiar oil-cushioned journal employed in the small machines is occasioned by the speed reduction secured. The journal shells are babbitt-lined and are split horizontally, the two halves being united by bolts with shim adjustment. Oil from a central system is introduced at the center under slight pressure, thoroughly flushing all parts. Axial adjustment is provided by metal shims arranged in quarter-box fashion. The diameter of the shaft at the journal of a 5,000-kw machine is 15 in., strikingly small in comparison to the 34-in. shafts required for a cross-compound reciprocating engine of corresponding capacity.

Longitudinal adjustment to preserve proper side clearances is secured by a thrust bearing located next to the outboard bearing. The bearing is not subjected to longitudinal thrusts from the action of the steam and is consequently of small size. The two half shells are advanced in opposite directions by graduated set-screws, so that the actual running clearances are measured in thousandths of an inch. Once set, these adjustments are permanent and do not require frequent "taking up."

Steam enters the turbine successively through an automatic quick-closing throttle, hand throttle, strainer and the main admission valve. A circular port surrounding the entrance to the initial stage conveys this steam to all points so as to avoid stresses incident to more localized admission of highly superheated steam.

An important feature of the steam distribution system is the provision of a by-pass valve. This valve admits high-pressure steam to the second stage of the turbine on overloads in order to increase its capacity up to 50 per cent. in excess of full-rated load. By properly proportioning the by-pass steam to the overload on the turbine, maximum economy may at all times be secured, together with reserve overload capacity. This results in a slight rise in the economy curve on heavy overloads, resembling in some respects the engine economy curve on loads exceeding that of maximum economy. The turbine, however, only suffers in economy at heavy overloads, while the engine economy decreases progressively from 75 to 80 per cent. of full-load capacity.

The main admission valve consists of a double-beat poppet valve, operated by a small piston, this in turn being controlled by a small pilot valve directly actuated by the governor mechanism. The valve admits steam to the turbine in puffs, the duration of which are proportioned by the governor to the load upon the turbine. This intermittent method obviates the throttling of steam to accommodate loading and secures the highest economy by using at all loads steam at boiler pressure.

At the extreme outer end of the turbine shaft is mounted a worm driving a short horizontal cross shaft. This shaft drives at one end the oil pump and at the other the governor through bevel gearing. An eccentric provides the reciprocating motion necessary for the valve mechanism.

The governor is of the fly-ball type, with 90° bell crank ball levers mounted on knife edges and fitted with roller contacts. The governor sleeve and spring is mounted on ball bearings, and adjustment of the spring tension may be made while the turbine is running, thus affording a most simple and convenient means for paralleling alternating-current generators and dividing the load proportionately between them.

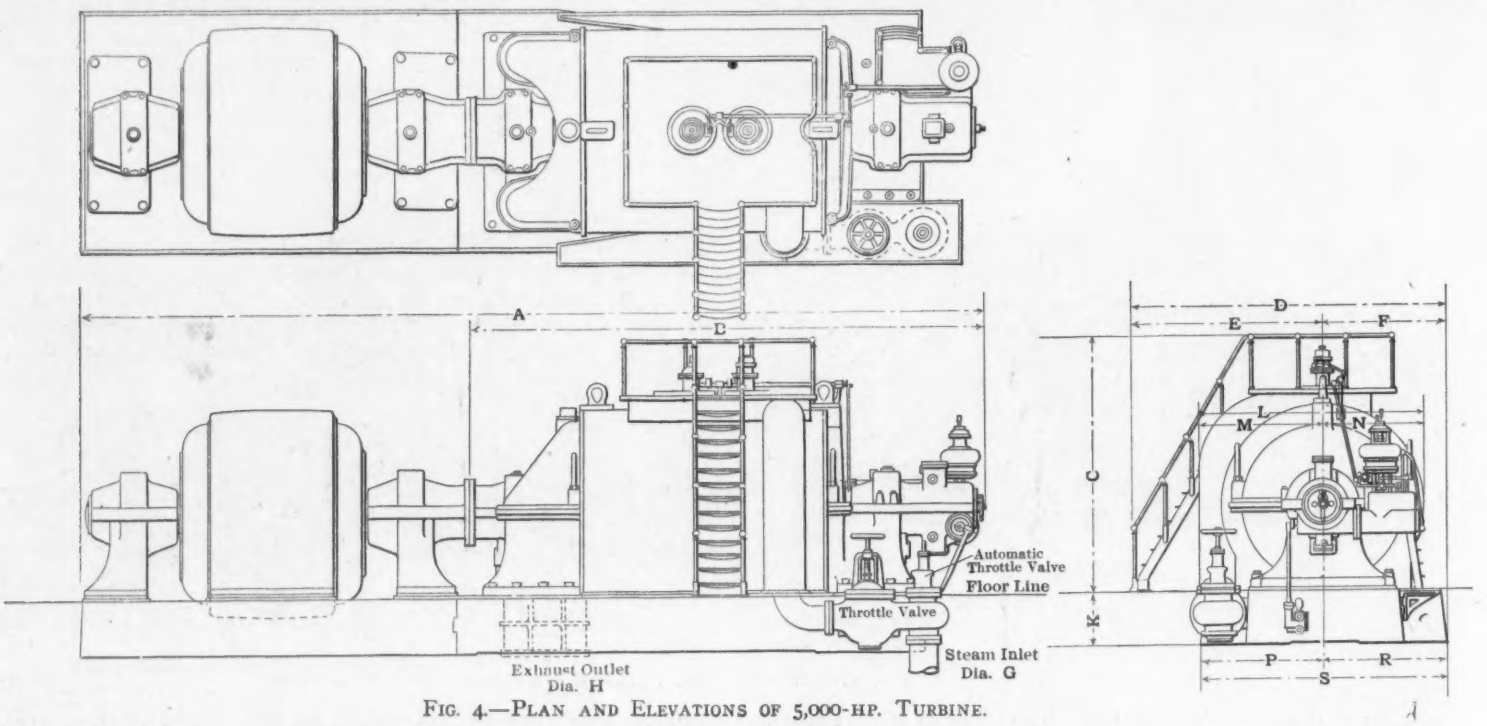


FIG. 4.—PLAN AND ELEVATIONS OF 5,000-HP. TURBINE.

At the extreme end of the outboard pedestal is mounted an auxiliary speed limit governor. It is likewise of the centrifugal type and may be set to release, at any predetermined speed, a small plunger valve, which controls with high-pressure steam the operation of the quick-closing throttle before mentioned. This is normally held open by means of an overbalanced differential piston. At the moment the speed limit operates, the excess pressure is removed and the throttle closes. This device is employed purely for insuring absolute immunity from accident from excess speeds, due to the possible disablement of the governor mechanism.

Copious lubrication is supplied to all journals by means of a plunger pump driven from the worm shaft. The warm oil returning from the bearings passes through a copper coil cooler in the bedplate and thence to a reservoir from which the pump draws its supply. The cooled lubricant is circulated at slight pressure, sufficient to insure positive flow. At no point is oil under high pressure employed for preventing erosion of rubbing parts, bearing areas being sufficient for supporting the weight of the rotating parts.

In general construction the 5,000-kw turbo-generators conform to those now building for smaller machines. The field or revolving element is built from a solid cylinder of steel slotted for the reception of the bar windings, and provided with ventilating openings corresponding with openings in the laminations of the stationary element. The generators may be wound for high voltage if desired, in order to avoid the use of step-up transformers in a system of power transmission at voltages ranging up to 15,000.

The 5,000-kw turbo-units here illustrated will be employed in heavy electric railway service, which is the most exacting encountered in central station operation. These machines will form the initial equipment of the Pennsylvania Railroad Terminal property in New York City, operating with electric locomotives the heaviest Pullman trains through the tunnel approaches to Manhattan. Three units will similarly inaugurate the power service on the Philadelphia Rapid Transit Subway system now under construction. Eight 5,000-kw units will furnish power to the London Subway system and three 3,500-kw units to the surface system of the same city. These units will operate under 175 pounds steam pressure, high vacuum and 100° to 175° of superheat.

Terminal Freight Telpherage.

The application of electricity to the unloading of steamship freight at terminals is even more interesting than its use in railroad freight yards, and it is necessary that every electrical engineer should be as thoroughly conversant with the adaptation of electricity to the handling of freight or other material as well as carrying passengers. The domain of electricity is continually increasing, and these later applications proclaim an advent into the great field of railway and steamship freight terminal transportation which has formerly been a "terra incognito" to electrical engineers.

It has always been difficult to handle freight to and from the steamboats, especially when side ports are employed. If the load is to be removed from the hatchways in the deck or from the deck itself, the work was comparatively simple, but the side ports have offered the following difficulties: Low headroom, little width and the rise and fall of the river, due either to freshets or tides, the great variety of the shapes and weights of a miscellaneous cargo.

In unloading, the whole cargo has to be moved through these narrow side ports, then into a narrow space, and then comes the utter-most effort to prevent congestion. What is desired is not only to get the cargo out as quickly as possible, but just as quickly to convey it to remote locations in the freight sheds or warehouses. This is most easily accomplished by telpherage. The portable electric hoist draws the loaded truck through the port, elevates it quickly and then the telpher transports at the rate of a quarter of a mile a minute. Therefore, it is the result of the trinity of "telpher, trailer and hoist." It is not sufficient to convey or hoist alone, but each is equally necessary, and the combination of the trailer with the other two gives the perfected result. More than one telpher combination is used, and as soon as one truck is hoisted and the telpher moves from the gangplank, another telpher waiting upon a side switch near the entrance slips in and the process can be made continuous, for as soon as the loaded truck is at the side of the port the hooks of the next hoist are waiting and ready.

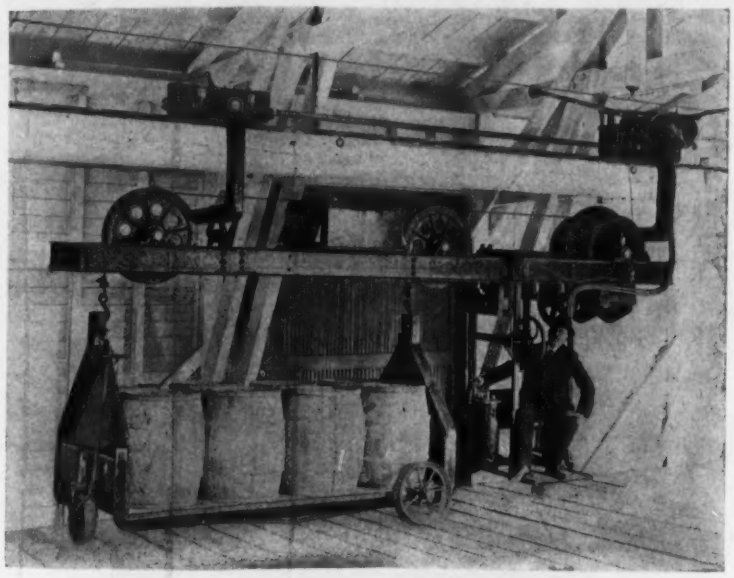


FIG. 2.—BARRELS IN TRANSIT.

In reference to the various views, these are so plain as to need but little explanation. They represent an installation made by the United Telpherage Company for the Old Dominion Steamship Company, of New York, at their southern terminal in Richmond, Va. Fig. 1 shows a load of bags being raised from a side port. Fig. 2 a truckload of barrels passing from the lower to the upper warehouse. Fig. 3 a load of boxes of cheese traversing a curve. Movable cross track can be connected with the side tracks so that every square foot of space can be covered by the telpher. A speed of 1,300 feet per minute is made with loads of 6,000 pounds.

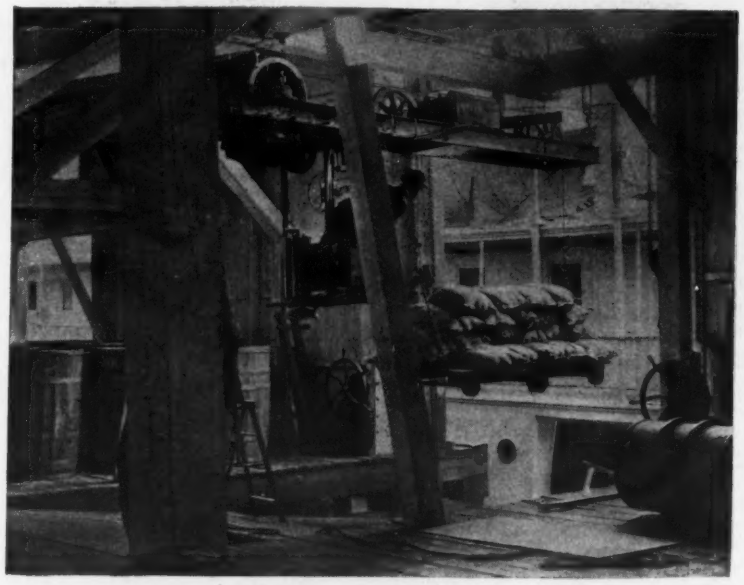


FIG. 1.—RAISING LOAD FROM SIDE PORT OF STEAMER.

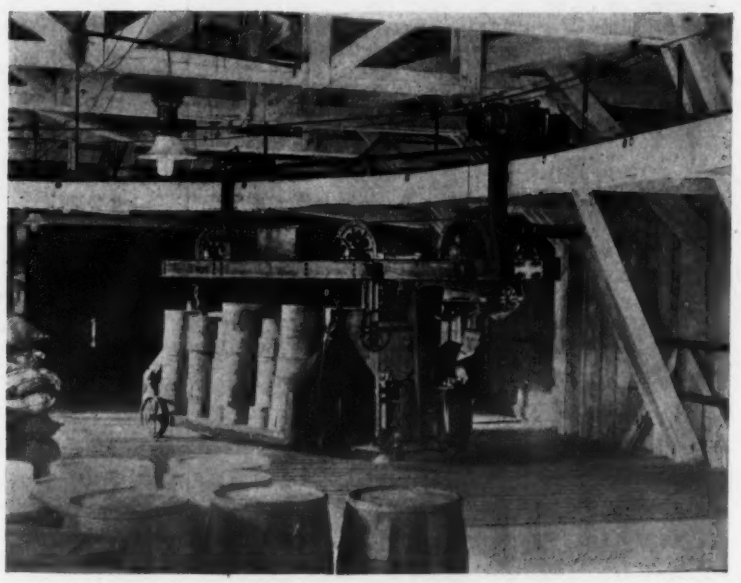


FIG. 3.—LOAD OF CHEESE TRAVERSING A SHARP CURVE.

Alternating-Current Wattmeter Testing Set.

We illustrate herewith a testing set made by the Sangamo Electric Company, of Springfield, Ill., for testing alternating-current wattmeters either in the station or on the consumer's premises, being designed for use on the standard indicating or integrating wattmeter. The purpose of the set is to give a wide range of loads under absolute control with a very small actual expenditure of energy for apparent heavy loads, these being obtained by means of a small transformer forming part of the outfit and enclosed in the same case. For light

FIG. 1.—TESTING SET.

loads, up to 120 or 150 watts, a set of non-inductive resistances and a small water rheostat are provided, also carried inside of the box, each resistance set being standardized for a certain wattage at any desired voltage.

Fig. 2 shows a diagram of connections. The water rheostat is on a third snap switch, and is operated by means of a fibre knob near the front of the box. This rheostat is composed of a heavy glass jar filled with water and made water-tight by rubber gaskets where the brass operating rod passes into it, the rod being moved vertically by

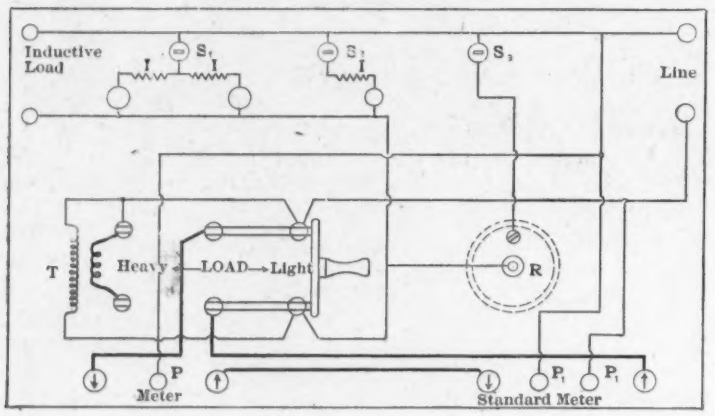


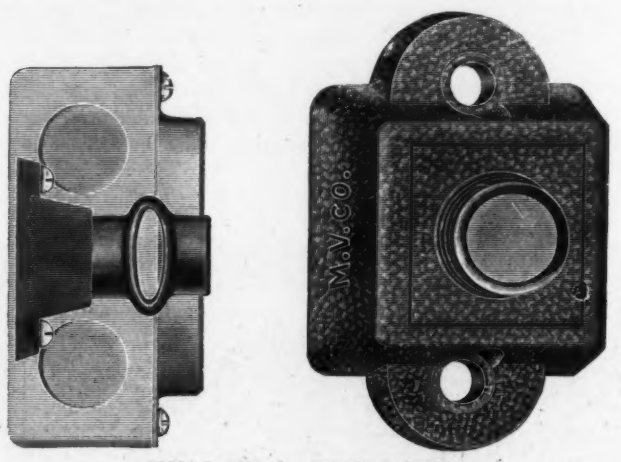
FIG. 2.—DIAGRAM OF CONNECTIONS.

the fibre knob to get any desired load within the range of the rheostat, which is about 5 to 30 watts. On the switch-plate of the set are the three indicating snap switches for the light loads, the various binding posts, the rheostat knob and a double-pole, double-throw switch. For light loads this switch is set in the position marked "light," all connections being then made so that the resistances and rheostat are an actual non-inductive load on the meter tested, the special transformer not being in circuit. For heavy loads, above 200 watts, the switch is thrown over to the position marked "heavy," changing the connections to the various parts of the apparatus. The primary of the small transformer is now in series with the standard resistance and rheostat, which thus become simple controllers for varying the pressure on the primary, giving a range of impressed e.m.f. from a few volts to the full-line pressure.

The secondary of the transformer is wound for two or three volts maximum and large capacity, and is at the same time connected directly to the series coils of the meter and standard wattmeter. These being of very low resistance, the full-load current will flow at from ½ to 1 volt pressure, according to the type of meter under test. Therefore, by varying the primary voltage on the transformer the secondary voltage and current may be varied as desired. The full-line e.m.f. is kept on the shunt coils of the meter under test and the standard in both positions of the switch, and as phase relations are said to be maintained correct by the special construction of the transformer, large loads are obtained with the switch in the "heavy" position with actually less power, so it is claimed, than is used for resistances on light loads. For inductive load, binding posts are provided for connecting an arc lamp, motor or reactance coil, the main switch being set in the "light" position, as the actual load must be used for this purpose. To facilitate the inspection of the water rheostat, the switch-plate is hinged at the back, being held in front by three knurled screws, which, when removed, allow the plate to be swung back without disturbing any connections. The various binding posts are marked with small plates near them, and the only part of the apparatus which needs attention is the water rheostat, which should be inspected occasionally to see that it is full enough, and that the rod is fairly clean.

Insulated Fixture Stud.

A new method of installing a fixture is provided by the Robb insulated fixture stud, which is shown in the accompanying cuts. With the old style the whole would usually project some four inches from



FIGS. 1 AND 2.—FIXTURE STUD.

the back of the box. With the Robb stud and "hickey" only, suppressing the insulating joint, the projection from the back of the box is only about two inches, with the appearance shown in Fig. 2. It allows the use of flat backs on all electrical brackets, as illustrated,

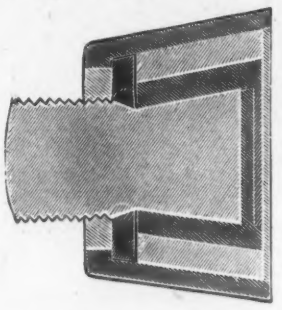


FIG. 3.—FIXTURE STUD.

and affords opportunities for taste and originality in design. As shown in Fig. 3, the device is insulated internally with pure mica, so that not only is the work of putting up fixtures simplified and economized, but a high degree of protection is assured. The appliance is made by the Mitchell-Vance Company, of New York City.

British Westinghouse Annual Report.

The British Westinghouse Electric & Manufacturing Company's fourth annual report issued to the stockholders under date London, December 17, says, in part: "The directors submit herewith the balance sheet for the year ending July 31, 1903, together with profit and loss account to that date, which shows a profit of £107,609.7.6. This includes about £60,000 special discounts allowed by the American companies on orders executed at Pittsburg. It was felt by the American companies that these discounts should be made in view of the fact that the Manchester factory could turn out only about one-third of the electrical apparatus needed for its orders and had, therefore, to purchase the balance from the Pittsburg factories.

"An interim divided at the rate of 6 per cent. per annum upon the preference shares has been paid. After providing for debenture and loan interest and the further items set out on the profit and loss account, a balance remains of £47,106.8.1. Out of this sum the directors recommend the payment of a final dividend at the rate of 6 per cent. per annum on the preference shares, absorbing £45,961.13, carrying the balance, £1,144.15.1, to reserve. This being the first year during which the company's works have been equipped it has not been thought necessary to make any provision for depreciation of buildings and machinery.

"The total authorized share capital of the company has now been issued. Under the provision of the articles of association, the directors have created a further £450,000 4 per cent. debenture stock to rank *pari passu* with the £787,500 previously created; £50,000 of this further debenture stock has already been issued. In order to make provision for maintaining a sufficient supply of stock at the company's works and for other purposes to meet the requirements of the increasing business of the company, the directors will propose to the meeting that an additional 100,000 6 per cent. preference shares of £5 each, ranking *pari passu* with those already existing, shall be created. Arrangements have been made under which the subscription to these shares will be assured. The works at Trafford Park are now employing over 5,000 hands. The following particulars are given as indicating the growth of the company's business: Orders received during the year ending July 31, 1901, £738,000; ending July 31, 1902, £932,000, and ending July 31, 1903, £1,657,114. Among other important contracts obtained during the past year are those with the Admiralty, the Midland Railway Company, the Metropolitan Railway Company, the North Eastern Railway Company, the Underground Electric Railways Company of London, the Buenos Ayres Western Railway Company, the Buenos Ayres Great Southern Railway Company, the De Beers Consolidated Diamond Mines, the London County Council, and the Corporations of Aberdeen, Bath, Bournemouth, Glasgow, Hackney, Ipswich, Liverpool, Salford and Dunedin, New Zealand, and the Savoy Hotel Company, London." It will be recalled that details regarding the major portion of these contracts have been exclusively noted, at the time of placing, in these pages.

The circular issued to the shareholders says, in part: "It has been thought advisable to postpone the annual general meeting until about the middle of January in order that the chairman, Mr. Westinghouse, who is detained in America, may be able to arrive in England and preside."

New High Voltage Oil Fuse.

The high-voltage oil fuse described below will appeal to superintendents of power houses as a means of protection against the damage to switchboards and machines caused by short circuits. This fuse is especially adapted to high-voltage lines and is very simple in construction.

The fuse consists of a glass tube with outwardly flanged ends, a fibre cap at each end being fastened to fibre collars which are held in position by the flanges on the glass. A brass rod fastened to each cap connects the fuse wire, which is made in the form of a link. The glass tube is filled with transformer oil to just above the upper extremity of the fuse wire, rubber washers and discs preventing the oil from leaking out. When the fuse blows, this oil immediately fills the gap caused by the broken fuse wire and forms an effective insulation which will prevent arcing on the highest voltages.

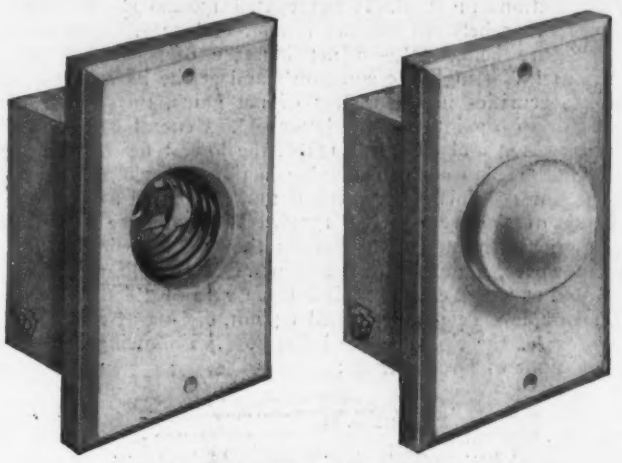
Tests have been made on this fuse by one of the most important plants in Canada, and these tests were evidently of a satisfactory nature, as they have decided to equip their plant with them for 50,000 volts.

One of the tests is worthy of mention. In order to make a thorough test of its current capacity they used a piece of No. 10 copper wire in place of the ordinary fuse wire and short-circuited the fuse on 2,200 volts with good results. The fusing point of No. 10 copper wire is 300 amp., which on 2,200 volts makes a current of 660 kw. The Anyun Lamp & Electric Company, of Buffalo, is the manufacturer.

Wall Box Receptacle.

A new wall box receptacle is the latest addition to the "P-K" line, made by the H. T. Paiste Co. It is constructed in one piece of porcelain, which prevents any grinding, and affords a "finish" to the plate that never tarnishes or changes. It takes any Edison attachment plug, which makes it available for immediate use in the many places where such a plug is already wired.

As the result of long experimenting, the concern is able to furnish



FIGS. 1 AND 2.—WALL BOX RECEPTACLES.

these receptacles and porcelain cap attachment plugs to match in five most artistic special finishes. Each receptacle is furnished with a special dummy plug which takes the place of the attachment plug when the latter is not needed, thus preserving the neatness of the receptacle.

The two illustrations show the device at a glance. Fig. 1 is a view of the receptacle ready for use and Fig. 2 shows it with a dummy plug in place.

Light and Power in Electricity Building, St. Louis.

Prof. W. E. Goldsborough, chief of the Department of Electricity, has issued data as follows in regard to the light and power service in Electricity Building, St. Louis Exposition:

Regarding the matter of electric service to be available in the Electricity Building during the time of the Exposition, arrangements have been made to supply the following service for commercial use in the above building, namely: 104-volt, 25-cycle, alternating current, 1 and 3-phase; 104-volt, 60-cycle, 1 and 2-phase; 6,600-volt, 25-cycle, 1 and 3-phase; 2,200-volt, 60-cycle, 1 and 2-phase; 2,200-volt, 60-cycle, 1 and 3-phase; 110-volt, 220-volt, and 500-volt, direct current.

For distribution of the above service the following plans have been adopted: 104-volt, 25-cycle, 300-kw available and distributed over entire building; 104-volt, 60-cycle, 100-kw, available and distributed over entire building; 110-volt, 220-volt and 500-volt, direct current, 100-kw, available and distributed over building; 6,600-volt, 25-cycle, 100-kw, available at transformer space only; 2,200-volt, 60-cycle, 50-kw, available at transformer space only; 2,200-volt, 50-cycle, 50-kw, available at transformer space only.

Should any exhibitor require service covered by the last three items it will be necessary for him to wire from his space to the transformer space located in the northwest corner of the Electricity Building. In addition to the service mentioned above, we will have at the transformer space a limited quantity of 340-volt, 25-cycle, one and three-phase, and 400-volt, 25-cycle, one and three-phase. These two items are for supplying current to rotary converters and motor-generators installed in the transformer space.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—There is more strength to the stock market, and a demand for high-grade dividend-paying shares of companies of established credit, as well as for bonds. The United States Steel securities were strong on the better impressions prevailing as to the outlook in the iron and steel industry. Not a little attention was paid to high-grade industrial dividend stocks, such as General Electric. Brooklyn Rapid Transit was a feature, there being further intimations that the money is being raised to carry out improvements in its terminal facilities and power plants with the aid of capitalists interested in other local traction concerns. The transactions in B. R. T. aggregated 156,200 shares, the range of prices being between 50, the lowest, and 53¾, the highest, the closing figure being 53⅛—a net increase of ⅜ point. General Electric and Westinghouse common stand at the head of the list of electrical securities in the matter of net gains, the former closing with a gain of 6 points and the latter 9⅝. General Electric touched 173, but reacted and closed at 171½, the lowest figure being 164½. Westinghouse showed considerable activity, 8,900 shares having changed hands. This stock reached 170 and closed at 168, the lowest figure of the week being 157½. Westinghouse preferred remained practically steady throughout the week, closing at 193, this being, however, a net loss of 2 points. Metropolitan Street Railway closed at 123⅛, ex. div., this being a gain of 3⅛ points. American Telegraph & Telephone gained 1 point, closing at 126, and Western Union ¼, the closing price being 86¼. Following are the closing quotations of December 29:

NEW YORK.

	Dec. 21	Dec. 29		Dec. 21	Dec. 29
American Tel. & Cable	80	80	General Electric	164	176
American Tel. & Tel.	125⅝	128⅛	Hudson River Tel.	..	..
American Dist. Tel.	24	24	Metropolitan St. Ry.	122¾	125⅜
Brooklyn Rapid Transit	50⅛	54	N. E. Elec. Veh. Trns.	..	..
Commercial Cable.	..	..	N. Y. & N. J. Tel.	..	..
Electric Boat.	15	15	Marconi Tel.	..	25
Electric Boat pfd.	40	40	Western Union Tel.	..	80⅛
Electric Lead Reduction.	⅝	1	Westinghouse com.	157	175⅛
Electric Vehicle.	5¼	5¼	Westinghouse pfd.	180	190
Electric Vehicle pfd.	8	9			

BOSTON.

	Dec. 21	Dec. 29		Dec. 21	Dec. 29
American Tel. & Tel	125¼	128	Western Tel. & Tel. pfd.	*81	78
Cumberland Telephone	*115	*114½	Mexican Telephone	1⅜	1⅜
Edison Elec. Illum.	220	232	New England Telephone	122	121
General Electric.	165	176	Mass. Elec. Ry.	18	20
Western Tel. & Tel.	7⅛	7⅛	Mass. Elec. Ry. pfd.	75	75¾

PHILADELPHIA.

	Dec. 21	Dec. 29		Dec. 21	Dec. 29
American Railways	43	43¾	Phila. Traction	..	97¾
Elec. Storage battery.	54	54	Phila. Electric	6	6
Elec. Storage Battery pfd.	54	54	Phila. Rapid Trans.	9¼	8⅝
Elec. Co. of America.	8	8⅛			

CHICAGO.

	Dec. 21	Dec. 29		Dec. 21	Dec. 29
Central Union Tel.	..	..	National Carbon pfd.	92	92
Chicago Edison.	..	..	Metropolitan Elev. com.	16	17
Chicago City Ry.	160	155	Union Traction	5⅛	6⅛
Chicago Tel. Co.	..	..	Union Traction pfd.	25⅛	*29
National Carbon	20	20¼			

*Asked

WESTINGHOUSE BUYS ROAD.—$2,000,000 6 per cent. notes of the Westinghouse Electric & Manufacturing Company have been issued for the purpose of paying in part for the Lackawanna & Wyoming Valley Rapid Transit Railway, which runs from Scranton to Wilkesbarre and other points in Pennsylvania. The road is 42 miles long. In addition to the issue of notes the company took money out of surplus earnings, about $4,000,000, to complete the payment for this property. Westinghouse interests say that the property is worth a great deal more than was paid for it. The object in purchasing this road is to demonstrate what can be accomplished by using electricity for motive power in the transportation of both freight and passengers. The company will begin at once to equip this line with the latest electrical apparatus. It is officially stated that as soon as the Westinghouse Company has equipped the road with electrical equipments arrangements have been already made to sell the property. It is presumed that the company which stands ready to take the property is one of the anthracite coal roads. If the Westinghouse Company deems it advisable to sell the road after it has been electrically equipped and in operation the transaction will show a substantial profit to the Westinghouse Company. The road was purchased from a Philadelphia syndicate and the purchase price has not as yet been stated.

WASHINGTON-BALTIMORE TROLLEY.—It is stated that the high-speed electric railway between Washington and Baltimore, with a branch to Annapolis, Md., already constructed from Washington to Laurel, Md., is to be completed. Cleveland capitalists are at the head of the company. Some time ago it went into the hands of receivers. It was announced that a proposition will be submitted to the creditors for their approval. It is expected that at least $2,000,000 will be required to complete the property, and about $250,000 is needed to provide for debts due. An underwriters' committee has undertaken to prepare a plan for completing the property, and in the meantime calls have been made upon the underwriters to protect their interests by advancing pro rata the sum of $250,000. The plan contemplates the formation of a syndicate, mainly of receipt holders. To facilitate efforts looking to the completion of the property, it is proposed to bring into the control of the committee the receipts representing bonds and stock and all the outstanding bonds and stock not represented by receipts, and to bring into the same control the various committees and boards authorized or elected by holders of stock, bonds, or receipts. The road will be thirty-one miles long.

DIVIDENDS.—The directors of the Mexican Telegraph Company have declared the regular quarterly dividend of 2½ per cent, payable January 14. The directors of the Central & South American Telegraph Company have declared the regular quarterly dividend of 1½ per cent, payable January 7. The directors of the E. W. Bliss Company have declared the regular quarterly dividend of 2½ per cent. on the common and 2 per cent on the preferred, payable January 2. Directors of the Philadelphia Company declared a dividend of 1½ per cent. on common, payable February 1, as registered January 2. It is the regular quarterly dividend. Directors of Westinghouse Electric have declared a quarterly dividend of 2½ per cent. on the preferred and assenting and non-assenting stocks, payable January 11. Hall Signal directors have declared the regular quarterly dividend of 1½ per cent on the common stock, payable January 1.

CINCINNATI GAS & ELECTRIC.—President Kenan reports a good business in 1903. At the end of the Company's fiscal year next spring there will be left after the payment of all dividends and fixed charges a large sum for a surplus fund. This will be a remarkable showing in view of the fact that at the last annual meeting there was a deficit of about $65,000. For the past month the net earnings of the comapny amounted to $26,000 over November of 1902. The increased output of gas for December, as compared with the first 15 days of December last year, was 10,966,000 cubic feet. During the first 15 days of the month the company had applications for 170 new gas connections, as compared with 61 for the same period last year. There was sold thus far this month 117 gas ranges; none last year. There have been secured 106 new electric light consumers, who will use 3,395 incandescent lamps. The company has now 417,785 incandescent lamps in use, as compared with 344,776 this time last year, being an increase of 21 per cent.

B. R. T. EXPENDITURES.—It is stated that the management of Brooklyn Rapid Transit Company has placed the financial needs of the company before the principal owners of the property, and these owners have canvassed the situation well enough to secure definite knowledge that from $15,000,000 to $20,000,000 of cash can be obtained by the company as it needs it, on a 5 per cent basis as a maximum rate. With this knowledge the company is preparing to go ahead with its contemplated improvements. Details of the plans for raising the money will be worked out from this time on. The company appears badly in need of new equipment in various directions.

MEXICAN TELEPHONE reports as follows:

	1903.	1902.		1901.
Sept. gross	$23,024	$20,907	Inc.	$2,117
Sept. net	11,925	9,548	Inc.	2,377
Seven months gross	158,958	139,937	Inc.	19,021
Seven months net	$80,119	$63,131	Inc.	$16,988
Surplus Sept. 30	4,759	4,302	Inc.	457

CUMBERLAND TELEPHONE.—The Cumberland Telephone Company reports for the month of November as follows:

	1903.	1902.	Changes.	
Gross	$314,563	$271,650	Inc.	$42,913
Expenses	177,987	170,960	Inc.	7,027
Net earnings	$136,576	$100,689	Inc.	$35,887
Charges	2,741	23,960	Dec.	1,219
Surplus	$13,834	$76,728	Inc.	$37,106

NORTHWESTERN TELEPHONE EARNINGS.—The Northwestern Telephone Company reports annual gross earnings of $902,802 to State Auditor Iverson, of Minnesota. Of this amount, the State received 3 per cent. as imposed by law, which amounted to $27,084.07.

ILLINOIS TUNNEL COMPANY.—It is announced that the Illinois Tunnel Company has practically completed its plan of taking over the Illinois Telephone & Telegraph Company. The 5 per cent. bonds of the telephone company, amounting to $5,000,000, have been redeemed at 110, and stock to the same amount has been taken up at par. The tunnel company has a capitalization of $30,000,000 in 5 per cent. bonds, and the balance of the bonds will be issued from time to time in extending the underground tunnel railway and freight distributing project. The Illinois Tunnel Company's aim is to act as a steam railway terminal. In doing this, it is expected to carry mail between the post-office and the railways, deliver coal, packages, freight, and all kinds of merchandise.

TWIN CITY RAPID TRANSIT BONDS.—It is announced that the Twin City Rapid Transit Company's directors have authorized an issue of $10,000,000 5 per cent. gold bonds of 1928. At the present time only $3,500,000 will be issued. Of this amount $1,000,000 is to cover expenditures on power plants, sub-stations, equipment and other improvements made in 1903. Another $1,000,000 is to be expended next year to finish the power plant and sub-stations. The remaining $1,500,000 will be used to complete two additional lines between St. Paul and Minneapolis and for the extension of other suburban lines.

MERGER IN PITSBURG.—A merger of the electric lighting and power plants in the coke regions and the Pittsburg, McKeesport & Connellsville Railway system has been effected, and an application for a charter for the combined interests will be made at Harrisburg December 31. It is said the capitalization will be considerably over $5,000,000. The new company, which will be known as the Western Pennsylvania Railways Company, will be in control of the entire lighting, power and street railway system of Westmoreland and Lafayette counties, as well as part of the trolley system of Allegheny County.

TELEPHONE FORECLOSURE.—Judge Swan, of the United States Circuit Court, at Detroit, on December 24, confirmed the foreclosure sale of the Michigan Telephone Company, to N. W. Harris, who represents the syndicate of bondholders and who bid $4,100,000 for the property at the sale of November 5. The petition of Charles Flowers and Samuel T. Douglass, the latter representing the minority stockholders' protective committee, asking that the sale be set aside, is dismissed. The cases will be appealed to the United States Court of Appeals in Cincinnati.

TELEGRAPH EARNINGS.—The Central & South American Telegraph Company reports for the December quarter $286,500 gross and $189,500 net; total surplus, $884,567 against $775,578 last year. The Mexican Telegraph Company reports $129,000 gross for the quarter, $104,500 net; total surplus, $1,430,052, against $1,204,529. The earnings of both companies show a steady growth year by year.

Commercial Intelligence.

THE WEEK IN TRADE.—The principal features were strong and exceptionally active markets for speculatively dealt-in staples, and fair re-orders from jobbers. Business in wholesale lines continues dull, which, however, is usual at this period of the year. Other notable features were the exceptional ease in the money market and the sustained better feeling in iron and steel. The events in industrial lines are the ending of the Colorado coal strikes and the gradual downward adjustment of wages in coal, coke and iron and steel to meet changed conditions of supply and demand. The year is, however, closing in many lines with a rather more cheerful sentiment than appeared possible some time ago. A more confident tone has been brought about in the structural steel market by the reaffirmation of prices for billet, plate and structural steel. Much buying is not expected, however, until after the new year, although Chicago reports that some good quantities of rails have been taken up. In coal a record production, 60,000,000 tons, of anthracite is noted, prices being steady throughout the year. This output is 13 per cent. more than that of the previous record year, 1901. The prices for raw textiles are a drawback, with which the cotton manufacturing trade is struggling. Eastern mills not well supplied with cotton are buying sparingly. In copper extreme dulness prevailed throughout the week, and practically no business was transacted. There is no demand, and consumers are slow in coming into the market. Prices are unchanged at 12⅜@12⅝c. for Lake; 12¼@12½c. for electrolytic, and 12⅛@12⅜c. for casting stock. The business failures for the five days ending with December 23, as reported by *Bradstreet's*, aggregated 243, against 239 the week previous, and 166 the corresponding week last year.

BRITISH TROLLEY RAILS.—A cable dispatch from London, of December 20, says: A rather striking effect of the tariff reform agitation is the determination of the London County Council to revise its policy in regard to the equipment of tram lines, and, instead of ordering rails from Belgium, from which country the lowest bid came, it will buy from a British firm. "The decision," said a member of the Council, "indicates how powerful are the forces working in favor of tariff reform." The decision of the London County Council not to buy Belgian rails is the final outcome of a long controversy. The subject came up on December 8, and a motion to refer the matter to the Highways Committee was adopted. In moving the resolution Col. Rotton said the workingmen of England required to have as much work as they could get during the coming winter, and therefore the question of sending work abroad became a burning one. From information he had received, said Col. Rotton, he found that the wages paid by the firm which was manufacturing the Council's rails were—for foremen, 9d. to 2d. per hour; for what were known as first hands, 6d. to 9d. per hour, and for laborers and all others, 3½d. to 5d. per hour. Were these, he would ask, the rates which were imposed upon English contractors? The Council, said Col. Rotton, had sent two contracts to Belgium representing a total sum of £75,619, about 50 per cent. of that would be paid to the workmen, the other half going for profit and material. That meant that £37,879 had been lost to English workmen. At the rate of 30s. a week that amount would have given employment to 25,610 men for one week, or 485 men for a whole year. Therefore, 485 men had, by reason of this contract, been unemployed for one year in the steel trade of England.

GAS AND ELECTRICITY.—An official of the New York Consolidated Gas Company is quoted as follows: "I wish we had all realized ten years ago how this city would have grown by this time. I think we would have enlarged our plant much more than we did, and those of us who have been interested in the consolidation of the various gas companies would certainly have provided for much more extensive business than we did. This is particularly true with reference to electric lighting. The earnings from our electric light plants alone are becoming the most important part of our business. The consumption of gas for fuel purposes is also becoming a greater factor than ever before. With the incoming municipal administration there is no doubt that our present differences with the city in regard to lighting can be satisfactory adjusted."

BELL TELEPHONE OUTPUT.—The American Telephone & Telegraph Company instrument statement for the month ended November 20 and since December 20 compares as follows:

	1903.	1902.	1901.
Gross output	96,963	93,487	88,497
Returned	32,297	36,838	27,510
Net output	64,666	56,649	60,987
Since December 20:			
Gross output	1,020,941	994,422	867,323
Returned	441,013	420,682	352,173
Net output	579,928	573,740	315,150
Total outstanding	3,730,248	3,099,346	2,467,966

CUSTOMS RULINGS.—It has just been held by legal authority that cable bought in England by the Commercial Cable Company and brought from Hawaii, must pay duty. General Appraiser Hay has handed down a decision on the classification of retort graphite and retort carbon, which are byproducts in the manufacture of gas from bituminous coal. They had been assessed at 35 per cent., as articles in chief value of carbon, but Mr. Hay sustained the contention of E. P. Earle, of New York, the importer, for classification as coke at 20 per cent.

SCHIEREN LEATHER BUILDING.—The Cruikshank Company has sold for Roosevelt Hospital 30, 32 and 34 Ferry Street, New York City, old four-story buildings, on plot 72.5 by 48.5. The buyer is ex-Mayor Charles A. Schieren, the well-known leather manufacturer, who already owned the adjoining property at the southwest corner of Cliff and Ferry Streets, and who will now carry forward the building operation, which he has had under consideration for several months.

OTIS ELEVATORS FOR LONDON HOTEL.—The London interests of the Otis Elevator Company have secured a contract for the equipment of the new Savoy Hotel extensions. The installation, including the eight Otis elevators in the existing buildings, will be one of the largest of its description in Great Britain. The present contract calls for nineteen elevators, comprising five large passenger, four baggage and ten service.

LIGHT AND POWER EQUIPMENT FOR MEXICAN MINES.—La Maria Mining Company, which is engaged in extensive mining operations in the vicinity of Morelia, State of Michoacan, Mexico, is in the market for considerable equipment, including machinery for a lighting and general power plant for its mines. Julio Ambrosino, of Morelia, is the controlling factor in the enterprise.

POWER & MINING MACHINERY COMPANY has issued a circular in regard to its recent changes. The officers are B. Guggenheim, president; Cyrus Robinson, vice-president; H. C. Holthoff, vice-president; Burdett Loomis, Jr., vice-president; B. T. Leuzarder, secretary; L. P. Feustman, treasurer; Hawley Pettibone, consulting engineer. The circular says: We beg to call to your attention that the Loomis-Pettibone Gas Machinery Company, after the recent increase in capital, has now been merged with the Holthoff Machinery Company, of Milwaukee, Wis., under the new corporate name of Power & Mining Machinery Company. We are making extensive improvements and additions to our Milwaukee plant to meet the increasing demand for the American Crossley gas engines, Loomis-Pettibone gas apparatus and Holthoff mining machinery. We shall continue, under Mr. Holthoff's personal supervision, the manufacture of mining, smelting and milling plants and machinery. The Loomis-Pettibone gas producers have established for themselves a world-wide reputation as the only gas producers successfully generating a fixed gas for power and metallurgical work from either anthracite or bituminous coals, coke or wood. The Crossley gas engine, of which there are over 50,000 in operation, and which we are now building as the American licensees, we believe to be the best gas engine on the market. The economies assured by our guarantee to produce power with a consumption of one pound of good bituminous coal per brake hp-hour, or with two and one-half pounds of wood, cannot fail to be of interest to all users of power, for whatever purpose.

HUDSON RIVER POWER LAKE.—A lake larger than Lake George, in which enough water may be stored to maintain the Hudson River at a normal height during the low-water period, is one of the results which the incorporators of the Hudson River Electric Power Company, of Queensbury, expect will follow the completion of their plans. This company was incorporated December 28, at Albany, with a capital of $1,000,000, and having for its purpose the development of the power and resources of the falls of the upper Hudson, and for the distribution of electric power as far west as Utica and Syracuse, and as far south as Hudson. It is expected that the company will build the immense storage reservoir in the Sacandaga Valley, for which the engineers of the Hudson River Water Power Company have been planning for the last two years. The dam and power station will be built at Conklingville, and about 600 pieces of property will be flooded, as well as several small hamlets. The law department of the company has been searching titles and getting options on property for several years, and it is anticipated that by the time permission is asked of the Legislature to construct the dam, the company will own every piece of property to be flooded.

EQUIPMENT FOR APARTMENT HOUSES, ETC.—Percival Robert Moses, 35 Nassau Street, New York, has secured the contract for the equipment of a six-storied hardware factory, which is under construction by Charles E. Ring on Kent Avenue, Brooklyn. The engine will be of 150-hp capacity, from the Fitchburg Engine Company. It will be direct connected to a 75-kw C & C generator. The boilers will be built by the Bigelow Company, 15 Cortlandt Street. Several motors have yet to be purchased. Mr. Moses is to act as engineer regarding the electrical and refrigerating equipment to be installed in the 12-story apartment hotel being built at Sixty-ninth Street and Broadway by the Construction & Spencer Realty Company, McCreery Building, Forty-second Street. It has not yet been decided what equipment will be installed. Plans are now being drawn up, however. An apartment hotel to be built at Eighty-ninth Street and Central Park West, will also be installed with a complete electrical steam and refrigerating plant under the supervision of Mr. Moses.

CURTIS TURBINE FOR MEXICO.—The plant of the Monterey Electric Light & Power Company is to be remodeled and considerably enlarged. The electrical engineering and contracting firm of J. G. White & Co. will undertake the work. Contracts have just been let for the major part of the new equipment, which will have a capacity of about 1,000 kw. A 500-kw Curtis turbine has been ordered. This will be the first large sized steam turbine to be installed in the Southern republic. Two 240-kw belt-driven alternators, one 125 engine-driven exciter generator, and two 7½-kw belted exciter generators, transformers, etc., have also been requisitioned for. The contract was awarded to the General Electric Company, which will also supply 150 fan motors. The boilers will be of Babcock & Wilcox build.

SOME C & C FOREIGN ORDERS.—The C & C Electric Company, 143 Liberty Street, New York, has recently taken various Manchurian, Mexican, Cuban and British orders. A 20-hp slow-speed direct connected motor has been ordered by H. B. Roelker, 41 Maiden Lane, for driving ice machinery in Manchuria. A 30-kw belted dynamo and switchboard has been requisitioned for shipment to Monterey, Mexico, for lighting purposes. A 13-kw generator—belted type—and two motors of 5-hp capacity each have been ordered for light and power use in Cuba. Several orders for motors have come in lately from C. R. Heap, of London.

ELECTRIC TRACTION FOR PROGRESO, YUCATAN.—An electric traction system is to be constructed at Progreso, the prosperous seaport of Yucatan. The United Railways of Yucatan, which operates several steam railroads, has been granted a concession by the municipal authorities. Lines are to be built on all the principal streets. Progreso, which has a population of about 20,000 inhabitants, possesses no means of locomotion to the business center, not even a hack line. The export commission house of Thebaud Brothers, Broad Street, New York, acts as purchasing agents for the United Railways.

EQUIPMENT FOR SAO PAULO.—The daily press reports that the General Electric Company had secured a contract for further equipment for the Rio Tiete water-power plant of the Sao Paulo Light, Tramway and Power Campany, Limited, of Sao Paulo, are premature, as the matter has not yet been decided. The contracts, which will include generators and water turbines, will probably be let shortly after the holidays through the New York offices of the Sao Paulo Company, 29 Broadway. Mr. F. S. Pearson is the principal New Yorker interested.

ELECTRICAL EXPOSITION IN WARSAW.—An electrical exposition is planned to be held in Warsaw, the capital of Poland, between May and September, 1904. The exhibition is to include a special section to be devoted to new inventions. Foreign firms are invited to take part. It is anticipated that exhibits will be allowed to enter Poland free of duty. Interested parties can secure further information from the committee, Philharmonia Building, Moninski Street, Warsaw.

ISAAC L. RICE COMPANIES TO MOVE.—The Consolidated Railway, Electric & Equipment Company, the Consolidated Railway, Lighting & Refrigerating Company, the Railway & Stationary Refrigerating Company, the Lindstrom Brake Company, the Electric Launch Company, the Electro-Dynamic Company, the Electric Boat Company, the Holland Torpedo Boat Company, and Isaac L. Rice himself are about to move their offices from the American Society Building to the Hanover National Bank Building.

MEXICAN TRACTION SYSTEM EXTENDED.—The line of the Campania de Ferrocaniles del Distrito Federal, which are controlled by the Mexico Electric Tramway, Limited, Mexico City, are to be extended. A road is to be built between Tlalpan and Tulpulco and Kochimilco, suburbs of Mexico City. These lines will aggregate about twenty miles. Construction will begin next month. The equipment will be purchased in the United States.

MACHINE SHOP EQUIPMENT.—The Shaw Electric Crane Company, of Muskegon, Mich., has secured a contract for a crane of 30-ton capacity, for installation in the machine shops of the Canton-Hankow railway, which the American China Development Company, 320 Broadway, of which William Barclay Parsons is president, is building in China. A large contract for machine tools, etc., was recently placed with Wonham & Magor, Morris Building.

DEAL IN PENNSYLVANIA.—The electric lighting and power plants in the Connellsville coke region and the Pittsburg, McKeesport & Connellsville Railway system are to be consolidated, and a new company with a capital of $5,000,000, to be known as the Western Pennsylvania Railway Company, will be organized to take over and run the properties.

AMERICANS AFTER MEXICAN WATER POWER.—Americans propose to construct an extensive water power plant in the vicinity of Morelia, State of Michonacan, Mexico. C. C. Place, A. D. Henderson and J. H. Wilcox, all of Oswego, N. Y., are the principal parties interested in the project. They have just returned from a trip to the southern republic.

LIGHTING EQUIPMENT FOR SYDNEY, N. S. W.—Mackenzie, Quarrier & Ferguson, 114 Liberty Street, has secured an order for a 150-hp Harrisburg simple engine, which is to be direct-connected to a General Electric generator of 100-kw capacity for lighting service in Sydney, New South Wales.

CHICAGO GAS ENGINE PLANT.—The Scudder Electric Company, of Chicago, Ill., has just placed an interesting contract with New York concerns. It calls for three 100-kw, C. & C. generators, direct-connected to Nash gas engines, operating on natural gas, for installation in a small, block-lighting, central-station plant.

CONTROLLERS, ETC., FOR ENGLAND.—The Electric Controller & Supply Company, of Cleveland, has secured some fair-sized British orders for its specialties through its London offices, 47 Victoria Street.

EXPORTS AND IMPORTS.—Details of eleven months' commerce of the year 1903 are just made public by the Department of Commerce and Labor through its Bureau of Statistics. They show an increase in practically all of the great groups into which the Bureau of Statistics divides the exports and in all of the groups into which it divides the imports. Agricultural products, as a whole, show an increase of $74,000,000; products of the forests, $10,000,000; products of the mines, $8,000,000; manufactures, $5,000,000, and miscellaneous articles, $2,000,000. In the single group, fisheries, is shown a slight decrease of a little more than $1,000,000. The figures for the month of November show a marked growth in exports of manufactures, the total for the month being $34,093,639, against $30,513,512 in November of last year. Agricultural products also show a marked increase in the month, the figures for November, 1903, being $114,172,255, against $83,035,850 in the same month of last year. The increase in agricultural exports occurs chiefly in cotton, of which the value of the month's exports is unusually high. The increase in exports of manufactures is distributed through many articles, but does not occur, as had been expected, in iron and steel. Possibly one reason is that the gain in bulk does not yet offset the lower prices at which such exports have been made. Total exports for the eleven months are $1,309,000,000 and imports $917,784,000.

MAIL TELPHERAGE IN ENGLAND.—A syndicate has been formed to develop in England the telpherage method of transmitting mail. A syndicate has been formed with a capital of £150,000, divided into 60,000 6 per cent. cumulative preference shares of £1 each, and 90,000 ordinary shares of £1 each. Two-thirds of the amount wanted will be raised in Italy and France, and one-third only in England. The syndicate is formed to take over the patents from Count Taeggi Piscicelli, the inventor, and to develop the system. The directors are the Duc D'Uzes, the Duc de Morny, the Marquis Des Cars, the Comte de Pradere, Sir Theodore Fry, Mr. Charles Edwards, Mr. Henry S. Saunders (a director of the Marconi Company), Count Piscicelli, and Mr. William Digby—the two last joining the board after allotment. England, Italy, France and Spain are represented on the directorate. The Count has nothing more nor less than the later telpherage system introduced of late so successfully by Mr. H. McL. Harding and the United Telpherage Company, who have now three or four score industrial plants in operation. In addition to using telpher motors, it is proposed also to stamp the letters in some way automatically at the drop boxes, but that seems quite an unnecessary refinement.

POWER PLANTS FOR SWITZERLAND.—Among the power stations which are now being built in Switzerland that of Lucerne, in Engelberg-Obermatt, takes a prominent place. Numerous bids were received for this work, and after careful selection by a committee of experts, the plan of the Oerlikon Company was accepted as the best. In consequence, this firm has received the contract for the apparatus for the power station at Obermatt and the substation at Lucerne. The capacity of the station will be 14,000 hp, and current will be transmitted to Lucerne at 27,000 volts over a 18½-mile line. In the Lucerne substation the potential will be reduced to 2,600 volts for transmission to surrounding, districts, including the entire canton of Obwalden. Current will also be supplied for the Lucerne-Engelberg Railway. Several weeks ago the great power station of the Compagnie Vaudoise des Forces Motrices des Lacs de Joux et de l'Orbe was put in operation. This power station will supply over 190 villages in the canton of Waadt with light and power. It will have a capacity of 10,000 hp, deriving its energy from the Lac de Joux Falls near Vallorbe. The alternators will generate directly 13,000 volts at which potential the current will be transmitted.

AUSTRO-GERMAN DEALS.—With regard to consolidations noted in our Digest this week, Mr. J. H. Worman, United States Consul General, at Munich, writes under date of November 5: "A fusion has taken place between the different electric companies of Austria and Germany. The Schuckert Company, of Nuremberg—which was one of the largest industrial enterprises for electricity in Europe, and maintained its branches not only in various cities of the Empire, but also in Austria, with headquarters in Vienna—effected early this year a union with the Siemens & Halske Company, of Berlin, and now a fusion has taken place between the Siemens & Halske Company and the Austrian Schuckert works, so that it may be said that there is at present one trust controlling the trade of both Germany and Austria, for it is proposed to bring under the control of this new combination all the enterprises for electricity in Austria and, of course, in turn, in Germany under one general trust. The capital of this new trust, as far as it covers the control of Austria, is estimated at 18,000,000 crowns ($3,654,000)." That will not go very far for a trust to cover so much ground.

GERMAN CABLE.—The fourth cable line to connect New York City directly with Continental Europe will be completed next year. There is already a German cable starting from the island of Borkum near the mouth of the Ems and extending to this city by way of Fayal in the Azores. The second line takes exactly the same route and has been completed as far as the Azores. The route has been illustrated in these pages. The German Government agreed to pay to the German Atlantic Telegraph Company $178,500 if the line was completed to the Azores by January 1, 1904. In spite of the very unfavorable weather conditions on the Atlantic during the past few months the line has been laid to the Azores and is now in operation between Borkum and Fayal. The second half of the line is now to be laid and the German Government has agreed to pay the company a certain sum if it is completed between the Azores and New York by January 1, 1905.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, manufacturer of the "Chloride" and "Exide" accumulator, has recently completed arrangements with the trustees of the estate of W. G. Warden, by which the company acquires the entire property situated on Allegheny Avenue, between Eighteenth and Twentieth Streets. The main building on Allegheny Avenue is a seven-story and basement brick structure, having two wings, and containing over 280,000 sq. ft. of floor space. Aside from this building, there are 16 other structures utilized for the different processes of manufacture by the company. The property covers over three acres of ground, and has a frontage on Allegheny Avenue of nearly 600 ft., and is bounded by the Philadelphia & Reading Railway and a branch of the Pennsylvania Railroad, thus giving unusual facilities for the handling of freight and express.

SALES OF TELEPHONE APPARATUS.—Among last week's switchboard shipments reported by the American Electric Telephone Company, of Chicago, are the following: Towner, N. D., one 100-line express; Adair, Ill., one 100-line express; Glenwood Junction, Mo., one 100-line express; Wessington, S. D., one 100-line express; Fairbault, Minn., one 50-line express; Whiting, Iowa, one 100-line express; Kremlin, Okla., one 100-line express; Auburn, Neb., one 540-line installed express; Pleasant Hill, Mo., one 200-line express; Yates, Mo., one 100-line express; Sargent, Mo., one 100-line express; Espyville Station, Pa., one 100-line express; Salisbury, Mo., one 100-line express; Savannah, Mo., two 200-line express; Wolsey, S. D., one 100-line express.

POWER IN SWITZERLAND.—The Motor Aktiengesellschaft für augswandte Elektricitaat of Baden, Switzerland, writes us: "With reference to your article on the Beznau hydro-electric plant in your export issue of November 7, we beg to inform you that the plant in question is owned and operated by our company. We may add that we have installed in Switzerland besides some minor plants the well-known plants at Spiez on the Kander (6,500 hp.), and at Hagneck on the Aare (5,200 hp). We are owners of some important water rights in the north of Italy, the utilization of which we are at present engaged in preparing."

ELECTRICAL EQUIPMENT & SUPPLY COMPANY, of Pittsburg, Pa., will start formally in business on January 2, with headquarters at 215½ Fourth Avenue. It will handle the detail apparatus and supplies of the Westinghouse Electric & Manufacturing Company, General Electric Company, Marshall-Sanders Company, and New England sockets and supplies, and the Shelby incandescent lamp. This list is already being enlarged. The officers of the company are J. H. Waugh, president; Thomas Watson, vice-president; C. G. Hussey, secretary and treasurer.

RAWSON ELECTRIC COMPANY.—It is stated that the Rawson Electric Company, of Elyria, Ohio, manufacturer of telephones and supplies, contemplates erecting a large factory that will employ 300 men. It will also manufacture telephone switchboards and other apparatus. The organization will probably take the form of a consolidation between several independent telephone manufacturers and patentees. Chicago men are prominent in the negotiations which have so far taken place.

MARINETTE IRON WORKS MFG. COMPANY, Marinette, Wis., has built and occupied quite a large factory at Chicago Heights, comprising one machine shop, 60 by 150 ft., one machine shop, 100 by 250 ft.; foundry, 100 by 200 ft.; blacksmith shop, 40 by 60 ft.; pattern shop, 40 by 50 ft.; pattern storehouse, 40 by 50 ft.; power house, 40 by 60 ft., and other smaller buildings, the entire plant being of brick and stone construction.

JAPANESE TRACTION PROJECT.—The construction of an electric railway between Kioto, the ancient capital of Japan, with a population of some 350,000, and Hiogo, another prominent city, is projected. The length of the line will be upwards of fifty miles.

BALL ENGINE ORDER.—The Hocking Valley Railroad has recently placed a contract for three direct-connected units. The Ball Engine Company, Erie, Pa., will furnish the engines.

General News.

THE TELEPHONE.

ELDORADO, ARK.—The Smith Local Telephone Company contemplates remodelling its long-distance lines. One hundred and fifty subscribers are furnished with service, the rates being $1.50 to $2 a month.

EUREKA SPRINGS, ARK.—On the death of the proprietor of the Eureka Springs Telephone System the management of the exchange passed into the hands of his executrix, Mrs. Emma F. Van Allen. She writes us that it is her plan to put in a number of party lines, and to erect a new 100-drop switchboard in the hope of increasing the number of subscribers. A 200-drop Telephone Mfg. Company's switchboard has been operated at this exchange.

FRUITVALE, COL.—The Fruitvale Nutrial Telephone Company has been incorporated with a capital stock of $1000. The directors are W. J. S. Henderson, D. L. Howard and others.

MACON, GA.—The City of Macon has made a new contract with the Southern Bell Telephone Company by which the latter pays a license of $250 and furnishes free telephones to the city, which will amount to $570 annually.

EGAN, ILL.—The Leaf River & Egan Telephone Company is preparing to build a line through this city.

ATKINSON, ILL.—Henry County Telephone Company has increased its capital stock from $2500 to $15,000.

CHICAGO, ILL.—The Automatic Telephone Company has increased its capital from $3,000,000 to $5,000,000.

CARTHAGE, ILL.—The East Carthage Telephone Company has been incorporated with a capital stock of $21,000. Directors: O. W. Cutler, C. G. Wright and others.

FAIRFIELD, ILL.—The Egyptian Telephone & Improvement Company has been incorporated with a capital stock of $2500. The incorporators are C. M. Brock, Luke Whitson and J. H. Morian.

COLLINSVILLE, ILL.—The Central Union Telephone Company has a force of men stringing a new telephone line from Centralia to Collinsville, Ill., where connection will be made with St. Louis.

EAST ST. LOUIS, ILL.—The management of the Wabash Railway Company is stringing wires along the right of way for a telephone service. The telegraph system will be kept intact, but it will not be used between local stations except in emergency.

MARION, IND.—The Central Union Telephone Company will spend several thousands of dollars in making improvements in this city.

BLOOMFIELD, IND.—Wm. Hawkins, of Freeman, has asked the town council for a franchise to establish another telephone system at this place.

WORTHINGTON, IND.—The Greene County Telephone Company has been incorporated with a capital stock of $10,000. Directors: W. H. Beatty and others.

DENVER, IND.—The Denver Mutual Co-operative Telephone Company is the name of a new company recently organized by the citizens of this place. The company has contracted for an exchange of business with the Peru Home Telephone Company. The new company has 75 subscribers to begin with.

SAN PIERRE, IND.—The Starke County Telephone Company has incorporated with a capital stock of $5000. The company will install telephone lines and exchanges in Starke, Laporte, Jasper and Pulaski counties. The principal exchange and office will be in San Pierre. Henry A. Smith, T. J. Weinkauff and William Swetzer are the incorporators.

INDIANAPOLIS, IND.—The progress made in telephony in Indiana is shown by the tax record in the Auditor of State's office. Eight years ago there were in the whole state 5677 telephones, independent and Bell together. To-day there are 80,000 independent and 22,000 Bell telephones in the state. That means one telephone for every 25 inhabitants.

CRAWFORDSVILLE, IND.—The Home Telephone Company is arranging to install a new 200-line section to its switchboard. The company will put in a new transfer system on the entire board. Four hundred applicants have been denied service during the past four months on account of inadequacy of the switchboard. The directors are considering the feasibility of putting in about 100 new cables to all parts of the city.

TERRE HAUTE, IND.—The Terre Haute Electric Company is constructing a new system of communication between the interurban cars on the Clinton electric line and the train despatcher of the road, whose office is in the car barns in this city. Instead of having telephones at the switches, as most electric lines have, each car is to have a telephone and when communication is desired a car can be reached at almost any place along the line.

LOGANSPORT, IND.—The Logansport Home Telephone Company has announced an increase in its rates for business telephones from $18 to $30 per year. This increase, however, does not affect subscribers who signed for five years' service when the system was still in course of construction. The company's managers say they have expended a large amount of money in making extensions and improvements and in securing long distance service for the benefit of patrons, and the amount of their investments and the additional cost of maintenance render it necessary to make the increase. The company cites the ordinance which provides that after the company has installed 1000 telephones within the corporate limits it shall have the right to charge for business telepones at the rate above mentioned. The company has now 1700 telephones in service in the city.

WEST UNION, IA.—O. W. Rogers will build a telephone line here in the Spring from West Union to Clermont.

WEBSTER CITY, IA.—The Stratford Independent Telephone Company, which proposes to install a plant in this city, will begin work January 1.

BOXHOLM, IA.—The Grant Township Mutual Telephone Company, of Boxholm, has been incorporated with a capital stock of $10,000. Alfred Sunberg is president and Axel Westeen is secretary.

ELECTRIC LIGHT AND POWER.

TEMPE, ARIZ.—P. E. Fuller, of Mesa, has prepared plans for the power plant of the Tempe Canal Company. The probable cost of work is $200,000.

COMPTON, CAL.—The Compton Water & Lighting Company has been incorporated with a capital of $25,000 by E. E. Moore, C. I. Mason, W. S. Davis and others, all of Compton.

SHOSHONE, IDA.—The Shoshone Electric Light & Power Company, Ltd., of Shoshone, has been incorporated to construct, operate and maintain an electric light and telephone system; capital, $25,000. Directors: Robert Hays, of Pocatello, Frank R. Gooding and Fred W. Gooding, of Shoshone, and others.

STERLING, ILL.—The local electric light company in the spring will expend about $15,000 in improving its hydraulic plant.

SHELBYVILLE, ILL.—The Shelbyville Water, Light & Heat Company has been incorporated with a capital stock of $50,000, for the purpose of establishing a plant in this city. The incorporators are C. C. Scovil, W. H. Beem, Max Kleeman, G. C. Bolinger, I. S. Storm, B. W. Kerr and W. S. Middlesworth. The franchise of the present water company, against which a heavy judgment was rendered at the last term of the Circuit Court and the plant ordered sold by Master in Chancery, expires in August, 1905, and it is the new company's purpose to be ready to do business by that time.

GIRARD, KAN.—The plans and specifications of E. H. Ricksecker, of Chanute, for the electric light plant have been adopted, and he has been employed as consulting engineer.

GALENA, KAN.—W. G. Sargent, of Joplin, Mo., is reported to have purchased water power and mills on Spring River, and the same will probably be developed for electrical purposes.

HANCOCK, MICH.—The City Council has entered into a three years' contract with the Houghton County Electric Light Company to furnish street lighting at $86 per lamp per year.

THREE RIVERS, MICH.—The Three Rivers Light & Power Company has purchased a large strip of land on the Portage River and has commenced excavations for a new channel to give the water a better fall to the power house.

KALAMAZOO, MICH.—C. H. Frisbee, of the Kalamazoo Valley Electric Company announces that his company will, in the spring, begin the erection of two new dams on Kalamazoo River, one near Ceresco and another near Plainwell, to have a combined capacity of about 6000 horsepower. The probable cost will be $500,000.

GRAND RAPIDS, MICH.—The Grand Rapids Edison Company has nearly completed the erection of a dam and power house on Flat river, about 1½ miles north of the village of Lowell, which is 18 miles east of Grand Rapids. The company's business has increased so rapidly that its four plants are insufficient and it is now operating auxiliary dynamos on the power of the municipal lighting plant and some of the local factories. The new plant near Lowell will put the company in good shape to handle all its business and much more. There are two dams, about a quarter of a mile apart. The upper dam includes a number of headgates in a heavy concrete and masonry wall which regulate the flow to the lower dam. This headwater has an eight-foot fall. Below this a turn in the river is cut off by a 35-foot canal cut through a hill, and giving a fall of 22 feet. The main dam is erected at the mouth of this canal, where it enters the river. A circular wall of masonry is utilized at this point. Here two modern headgates 9 feet in diameter and 65 feet in length are located, and in these will be placed the 10 turbines. The power plant is a modern fireproof building with concrete floors and steel roof. It will be equipped with two generators of 450-kw capacity. There will be no transformation at the plant, but the high tension wires will be carried to Grand Rapids, where, at the city limits they will enter conduits extending to the Grand Rapids plant of the company. Here the current will be stepped down to about 220.

MEXICO, MO.—The Mexico Electric Light Company, recently purchased from Macon men by local capitalists, is buying new machinery and adding to the plant in anticipation of installing 24-hour service.

WARRENSBURG, MO.—At a meeting of the City Council the city attorney was instructed to draft an ordinance, submitting to a vote of the citizens of Warrensburg a proposition for public ownership of an electric light plant.

COLUMBIA, MO.—At a meeting of the City Council it was decided to buy the water and light plant owned by the Columbia Water & Light Company. A committee consisting of six business men of Columbia and two experts was appointed to appraise the value of the plant, the city and the company agreeing to accept the decision of the committee.

SEDALIA, MO.—Messrs. James Green, George Blackford, Horace S. and Moses Rumsey, all of St. Louis, Mo., representing all of the shareholders in the Sedalia Gas & Fuel Company and the Sedalia Electric Light & Power Company, voted at a called meeting, held at Sedalia, Dec. 14, to sell the franchises, rights and properties of the two companies to Joseph Clarke and Horace Rumsey. This sale was in furtherance of a merger plan, which practically consummates and by which the Sedalia Gas Company and its plants and the Sedalia Water Company, with its electrical interests and power plants, are consolidated under one management.

RED LODGE, MONT.—The city council has under consideration a proposition to bond the city to raise funds for the installation of an electric light plant. The matter will probably be submitted to a vote of the citizens in the near future. The establishment of a power plant on Rock Creek is also planned by the promotors.

BURLINGTON, N. C.—Electric light bonds amounting to $30,000 have been sold.

CADIZ, OHIO.—The Cadiz Electric Light & Power Company has increased its capital stock from $15,000 to $20,000 and will make improvements to its system.

MANTUA, OHIO.—The Mantua Electric Light & Power Company is installing its new plant and it is expected that it will start operations in the near future.

THE ELECTRIC RAILWAY.

SANTA BARBARA, CAL.—The Edison Electric Company has been granted a franchise to operate an electric railway between Santa Barbara and Summerland, 8 miles south of Santa Barbara.

STAMFORD, CONN.—The New York & Stamford Railway Company will build 50 miles of additional trolley lines in Westchester County. One line will extend to the Fairfield Golf Club, near Greenwich.

BOISE, IDA.—The franchise and holdings of the Boise Rapid Transit Company have been purchased by Cyrus Pierce, Howard Butcher, Jr., and J. W. Anderson, of Philadelphia, for a consideration of approximately $95,000. The new owners of the system have announced their intention of greatly improving and enlarging the service, and will construct a line through South Boise as far as the towns of Star and Pearl.

CHICAGO, ILL.—The Indiana-Chicago Air Line has completed surveys for an electric railway from South Bend to Chicago, by way of Michigan City. A spur from East Chicago to Indiana Harbor is already in operation. This line will connect with sections already built east of South Bend, and within a year it is expected that through trains will be run from Cleveland to Chicago by electric power. Both passenger and freight service are being provided for. The line is controlled by the Stone-Allen-Hanna syndicate of Cleveland, of which Luther Allen is president. The power house for the system between South Bend and Chicago will be located at Michigan City.

INDIANAPOLIS, IND.—The Dayton & Western Traction Company, of Indiana, has filed articles of incorporation. The capital stock is $10,000. The Indiana directors are H. C. Starr and J. R. Robinson, of Richmond. The company is the Indiana branch of the Ohio company of the same name.

VINCENNES, IND.—The following officers have been elected for the Vincennes, West Baden & Louisville Traction Company: Thomas H. Adams, of Vincennes, president; A. Norvale, of Cincinnati, first vice-president; Smiley N. Chambers, of Indianapolis, second vice-president; Fred Chapelle, of Petersburg, secretary; J. O. Davis, of Petersburg, treasurer. It was decided to issue bonds to the amount of $1,500,000, which will be taken by the Municipal Bond & Security Company, of Cincinnati. A trust company of Indianapolis and one at Cincinnati will act as trustees for the road.

LOUISVILLE, KY.—At the regular annual meeting of the stockholders of the Louisville & Eastern Railroad the present officers were re-elected. The proposed extension of the line to Shelbyville was discussed, but nothing definite was decided upon. It was decided to devote the profits of the past year to improvements, instead of paying dividends. A new station will be built at Pewee Valley, which will cost several thousand dollars.

BANGOR, ME.—Plans are now being made for the construction of two important electric railways—one from Bangor to Dexter, a distance of 35 miles, and the other from Rockland to South Thomaston and Owl's Head. The former is to be built by the recently incorporated Eastern Traction Company, of Bangor, capitalized at $180,000, with Forest J. Martin, Charles W. Mullen, Fred T. Dow and H. Franklin Bailey, of Bangor, and W. H. Waterhouse and E. B. Weeks, of Oldtown, as directors. Contracts have been closed for the rails, and ties for the Rockland, South Thomaston & Owl's Head line, and estimates are being made on the electrical equipment and construction. This line may be extended to Port Clyde and Tenant's Harbor, St. George.

MIDDLEBORO, MASS.—At the first corporation meeting of the Plymouth, Carver & Wareham Street Railway Company these officers were elected: Henry S. Griffith, Carver, president; William S. Kyle, Plymouth, vice-president; James B. Collingwood, Plymouth, secretary and treasurer.

FALMOUTH, MASS.—The Cape Cod Street Railway Company held a meeting here a few days ago, at which it was stated that the plans of the company for building its proposed line had been unavoidably delayed. The company will now have to petition the Legislature for an extension of its charter, and will be obliged to ask the Selectmen of Falmouth to extend its franchise in that town.

ALPENA, MICH.—Surveys are now being made for the electric railway which J. W. Boynton proposes to build from South Bend, Ind., to Alpena.

ATLANTIC CITY, N. J.—The Central Passenger Railway Company has applied to the Council for a franchise to construct a crosstown electric railway running from the beach ends of Virginia and South Carolina Avenue to Adriatic Avenue.

NEW YORK, N. Y.—The Jamaica & South Shore Railroad Company, Queens Borough, New York, has been incorporated, capital, $500,000. Directors: W. F. Brown and Joseph Kenny, Brooklyn; F. E. Haff, Long Island City, and H. A. Howarth, New York. This is a re-organization of the New York & Rockaway Railroad Company.

PENN YAN, N. Y.—The amended incorporation papers of the Lake Keuka & East Side Electric Railroad Company show that the capital stock will be $130,000. The directors for the first year are James T. Harris, Joseph C. Harris and Charles H. Hanscomb, of New York; Morris F. Sheppard, William H. Fox and Charles H. Sisson, of Penn Yan; David H. Hoover, of Keuka Landing; Frederick Crosby, of Crosby's Landing, and J. Monroe Shoemaker, of Elmira. The road will run from Penn Yan along the eastern shore of Lake Keuka to Keuka Landing, 12 miles from Penn Yan, and eventually it will be extended to Hammondsport, making the total distance 22 miles.

HAMILTON, OHIO.—The Cincinnati, Dayton & Toledo Traction Company is having preliminary plans prepared for a large central power station to operate the entire system from Dayton to Cincinnati, together with the Hamilton city lines. Current will be distributed through high-tension lines and sub-stations, following the most modern practice. At present the system is operated by five power stations with direct-current equipment. The station will be erected in Hamilton, which is about the load center of the system, and it is probable that present station buildings will be used for sub-stations.

NEW INDUSTRIAL COMPANIES.

THE INTERSTATE RAILWAY TRACTION COMPANY, of Dubuque, Ia., has been incorporated with a capital of $50,000; capital in Illinois, $5000.

THE VESTA STORAGE BATTERY COMPANY, of Portland, Me., has been incorporated with a capital of $1,000,000. Capital in Illinois, $2000.

THE ONE RAIL TRACTION COMPANY, of New York, has been incorporated by Louis J. Somerville, Brooklyn; Harry T. Stresser, Jersey City, and Alfred H. Wilmot, Brooklyn.

THE BUFFALO ELECTRIC CONTRACTING COMPANY, of Buffalo, N. Y., has been incorporated; capital, $5000. Directors: L. Y. Mayer, Joseph B. Mayer and J. J. O'Leary, Buffalo.

THE CINCH CLINCH ELECTRIC SUPPLY MFG. COMPANY, of New York; capital, $200,000, has been incorporated. Directors: J. F. Jacobs, Brooklyn; C. V. Ware and I. H. Lehman, New York.

THE WILMINGTON WATER & LIGHT COMPANY, of Wilmington, Ohio, has been incorporated at Camden, N. J.; capital, $125,000. Incorporators: S. S. Holbrook, G. H. B. Martin and J. F. Cotter.

THE AMERICAN TELEGRAPHOPHONE COMPANY has been incorporated at Washington, D. C., by Stilson Hutchins, Lee Hutchins, Z. R. Babbitt and William J. Dante; capital stock, $5,000,000.

THE OMAHA LIGHTNING ROD & ELECTRIC COMPANY has filed articles of incorporation, the capital stock being fixed at $20,000. The incorporators are S. M. Elwood, B. W. Yoho, J. K. Chalfant and Fred Craff. It will manufacture lightning rods and electric machines.

THE KINGS COUNTY AUTOMOBILE COMPANY, Brooklyn, N. Y., has been incorporated to manufacture automobiles; capital, $10,000. Incorporators: H. Aufderheide, H. W. Palmer, Brooklyn, N. Y.; P. Schissel, Forest Park, L. I., N. Y.

THE WALDORF AUTOMOBILE COMPANY, of New York City, has been incorporated to manufacture automobiles; capital, $500. Incorporators and directors for the first year: F. W. Chapman, L. O. Weilbacher, H. R. Weilbacher, New York City.

THE AMERICAN AUTOMOBILE & POWER COMPANY has been organized at Sanford, Me., to deal in automobiles and machinery; capital stock, $500,000; $50,000 paid in. The promotors are Chester I. Campbell, Samuel E. Ward, Henry C. Long, treasurer, Boston; Everett M. Goodall, Fred B. Averill, Sanford, Me.

LEGAL.

VERDICT FIVE CENTS.—Constable John Small has won a suit for five cents against the Chicago Telephone Company, because the latter did not return five cents on failing to make a connection on a slot machine. The court decreed that the company must return the nickel and pay the costs, which amounted to $7.40.

RIGHT TO MAINTAIN A BRIDGE TO CONNECT ELEVATED LINES.—Judge Honore, of Chicago, has decided that the Union Elevated Railroad Company has the right to maintain a bridge to Rothschild & Company's store from the State Street station. The store and the loop company asked that the city be restrained from tearing down the bridge, and the court made the injunction against the city permanent.

STORAGE BATTERY LITIGATION.—The Electric Storage Battery Company, of New Jersey, has applied to the United States Court for an injunction to prevent the Dayton & Muncie Traction Company from using certain electrical devices on which it claims patent rights. In the complaint it is charged that a regulation system for electric railways and electric power, for which the Electric Storage Battery Company has exclusive rights, is about to be introduced into the traction company's power houses, and it asks that it be prevented.

THE DEADLY NON-GROUNDED LOW TENSION CIRCUIT AGAIN.—The Oshkosh Gaslight Company and the Oshkosh Electric Light & Power Company, Wis., have settled for the death of Olive Oaks, a young girl who was killed while turning on an electric light in her home last year, by paying her parents $1400, suit having been brought for $5000. A cross of wires during a sleet and wind storm grounded a 3500-volt circuit through Miss Oaks as she stood on an iron heating register in the act of turning a switch. The plaintiff based suit on the alleged defect in wiring.

DAMAGE BY ELEVATED ROADS.—In New York City, the Cooper Union has just had a large award in its favor against the Manhattan Elevated for damages. The amount is $130,000. In Boston, the first verdict in the numerous damage suits brought against the Boston Elevated Railroad Company was returned recently in the Superior Court for Suffolk County, a jury deciding against the road and fixing damages at $9938. This suit was brought by a trustee of buildings situated near the elevated structure in the South End to recover $30,000 for alleged injury to property through noise, dust, and invasion of the occupants' right to privacy consequent upon the operation of trains. Other suits to recover damages of more than half a million dollars are pending.

MULTIPLE VOLTAGE DRIVE.—The Bullock Electric Mfg. Company, by Mr. L. Lowenberg, secretary's office advises us as follows: "The Bullock Electric Mfg. Company's claims to the exclusive rights under the Ward Leonard patents to install multiple voltage system of electric drive for operating machines is sustained. This decision was rendered by Judge Kirkpatrick, of the Circuit Court, Dec. 2, 1903, in the suit of the Bullock Electric Mfg. Company, of Cincinnati, Ohio, vs. the Crocker Wheeler Company, of Ampere, N. J. This system provides the only successful means of operating and controlling motors driving machinery which requires variable speeds. This opportunity is taken of warning intending purchasers of multiple voltage apparatus that the Bullock Company will vigorously protect its rights under the patent."

OBITUARY.

MR. JOHN H. GRAHAM.—The many friends of the senior member of Graham Bros. Company, Hudson Street, New York City, are grieved to note his death on Dec. 13, after a long and busy career, largely devoted to electrical industries. Until the last few years he had been constantly engaged in the electrical field since 1877 and took a keen interest in its development. In the year named he was with Mr. (now Sir) Hiram N. Maxim. He was connected with the Brush Electric Company, 1879-80; the old United States Electric Company; the Schuyler Electric Company and the Waterhouse Electric & Mfg. Company; and then engaged in the construction and repair business. He was of a cheerful and sunny disposition and was widely esteemed. He was a Mason. During the past few years, his health declined rapidly. The body has been cremated in accordance with his wishes.

EDUCATIONAL.

FREE LECTURES.—The New York Board of Education is continuing next year its admirable free lectures under Dr. H. M. Leipziger, and the courses for January and February include lectures on electricity by Messrs. W. W. Ker and Mr. T. I. Jones, who have courses of eight and eleven lectures on the subject.

COLUMBIA UNIVERSITY, N. Y.—A number of investigations of considerable interest are being carried on in the newly established Phœnix laboratories for advanced research in physics at Columbia University. Professor Nichols is occupied with several investigations on the behavior of a charge of static electricity in the magnetic field and the possibility of producing a drag in the lines of static force. Dr. Pegram is working with Professor Nichols on his investigations, and is also studying the ionization of gases by heat, and studying various phenomena connected with radium and other radio-active materials. Dr. Davis is continuing his investigation on the effect of ionization on the radiation of luminous gases, and is also working with Mr. Hendren on the rate of re-combination of ions in high vacuo. Dr. Davis and Mr. Wheeler are investigating the minimum velocity of cathode rays necessary to produce x rays. Professor Parker, Dr. Day and Messrs. Fountain and Blake are also carrying on electrical investigations. Mr. Trowbridge is investigating the peculiarities of the electrodeless discharge at very low temperatures, in an endeavor to throw some light upon the peculiar phenomena which accompany the passage of certain meteors, whose trail remains visible for a long time after the stone has actually passed. Miss Stone, of the department of physics at Vassar College, who devotes her Saturdays to work in the Columbia laboratories, is continuing her investigations on thin platinum films deposited by the cathode discharge in vacuo. She has succeeded in developing some very interesting phenomena that promise to have an important bearing upon the structure of the cathode discharge.

PERSONAL.

CAPT. W. L. CANDEE, joint manager of the Okonite Company, has returned from a short trip to Europe.

MR. H. WARD LEONARD has, we regret to state, been confined to the hospital at Bronxville, N. Y., on account of trouble with one of his eyes. It is hoped and believed that he will soon be convalescent.

MR. T. F. MANVILLE, president of the H. W. Johns-Manville Company, started for the West on Dec. 22, and before returning to New York will visit the company's branches in Milwaukee, Chicago, St. Louis and New Orleans.

MR. SAMUEL PUTNAM AVERY offers, in memory of his son, Henry Ogden Avery, a prize of $50 for an electrolier, suitable for a newel-post in the hall of a public library. The design must represent a single female figure, draped.

MR. I. STERNFELD, the recently appointed general manager for G. & O. Braniff, Mexico City, which represents the Westinghouse interests in the Southern Republic, is at present in New York at the export offices of the Westinghouse Company, Hanover National Bank Building.

MR. W. J. BRYAN, former Democratic candidate for the presidency, has been touring Europe amongst the royalties with great eclat. He contributes to the *New York Journal* an article on the marvellous benefits from municipal ownership. What Mr. Bryan does not know on the subject would fill a library.

MR. EMILIO DYSTERUD, general manager of the Monterey Electric Light & Power Company, who has been in the States for several months past, will leave very shortly for home. The plant is to be remodeled and largely added to. Mr. Dysterud, while here, may be found at the Federal Electric Company, Washington Life Building.

MR. A. W. BUCKS has taken the management of the Chicago office of the Electric Machinery Company, of Minneapolis, Minn. This office is at the Ellsworth Building, 353 Dearborn Street. The apparatus he will handle comprises direct current motors and generators, and inductor type alternating current generators.

MR. W. J. WILGUS, fifth vice-president of the New York Central Railroad, has just returned from a six-weeks' trip through England, Scotland, France, etc., studying electric railway practice and particularly railroad terminal facilities. He does not appear to admire the methods of the Paris Underground any more than he does the jagged skyscraper outline of New York thoroughfares.

MR. H. L. SHIPPY, of John A. Roebling's Sons & Company, who has recently been ill with appendicitis has recovered we are very glad to say, and has so far convalesced as to be able to visit his office last week. For his friends, his return to health and strength has been one of the pleasures of Christmas and all have joined with special heartiness in wishing him a happy New Year.

MESSRS. H. HINE and Leonard C. Curtis, who have been in New York for several days past conferring with Mr. Charles A. Coffin, president of the General Electric Company, and John Hays Hammond, regarding new power transmission projects of the Guanajuato Electric Light & Power Company, in which concern all are largely interested, have left for Colorado Springs whence Mr. Hine will go direct to Mexico.

PROF. A. G. BELL.—Private dispatches received from Prof. Alexander Graham Bell state that he expects to return to Washington from Genoa on Jan. 15 with the remains of James Smithson, the English founder of the Smithsonian Institution. Prof Bell offered three years ago to bring the remains of Smithson here at his own expense, and renewed the offer last Spring. The action is taken with the sanction and authority of the Regents of the Smithsonian Institution. It is expected that there will be no opposition to the removal of the body. The removal of the remains at this time is desirable because a stone quarry has encroached on the English Cemetery at Genoa to such an extent that it has become necessary to move the bodies buried there.

DR. C. H. SHARP.—Dr. Clayton H. Sharp, engineer of the electrical testing laboratories of the Lamp Testing Bureau, New York City, has returned from an interesting trip to Europe, where he visited all of the principal electrical laboratories. Dr. Sharp gathered a mass of data and information which will enable him to fit up the new laboratories of the company at 80th Street and East End Avenue with the most complete and up-to-date apparatus and by the best methods known. He carried with him a number of carefully prepared standard photometer lamps, which were compared by the principal photometrists of Europe with their authorized standards, and found to be in extremely close agreement with the best of them. The Lamp-Testing Bureau will probably occupy their new laboratories in January, 1904.

HON. WILLIAM J. BUCHANAN, who was recently appointed by President Roosevelt to the post of Envoy Extraordinary and Minister Plenipotentiary of the United States to Panama and who left about a fortnight ago on a special mission to that part of the world, will return within the next few weeks for the purpose of taking general charge of the various Westinghouse interests in Europe. Mr. Buchanan was appointed in 1894 United States minister to the Argentine Republic, and served there until 1900, when he returned to this country and became director-general of the Pan-American Exposition. After his duties at Buffalo had ended he went back to the Argentine Republic to settle up some affairs for the United States. Until recently he has acted as South American agent of the New York Life Insurance Company.

MR. C. H. WILLIAMS.—A report that will be one of the most prominent and most useful features of the 27th convention of the National Electric Light Association, to be held in Boston next May, will be that of Mr. Charles H. Williams, of Madison, Wis., editor of the "wrinkle department." Mr. Williams has sent out to members a circular letter, asking each of them to make at least one contribution to this report, in the shape of a description of some method not in general use in connection with the manufacture, distribution or sale of electric energy, by which some difficulty has been overcome or some result obtained. A few sample "wrinkles" were sent with the letter, showing the general character of information desired and the style in which it should be formulated. A good many replies have already been received, and Mr. Williams is encouraged to believe that his report will be very successful.

MR. CHARLES R. PRATT has opened an office at 160 5th Ave., New York, as consulting engineer. He intends to work along the lines of general electrical engineering, while making a specialty of elevator and escalator work as well as advising in new ventures as to shop cost of construction of new apparatus and cost of machinery, machine tools, etc., to be installed. Mr. Pratt's long connection (24 years) as superintendent and engineer of some of the largest machine shops in the country has given him valuable knowledge in this line. Mr. Pratt was with the Sprague Elevator Company for years and aided in the development of the Sprague elevator, which is in such general use to-day. For the last few years Mr. Pratt has been with the Marine Engine & Machine Company, Harrison, N. J. His work in the electric elevator field has been highly successful and has besides given him an intimate insight into the solution of electrical problems.

DR. GEORGE F. KUNZ, who has been making a careful study of radium, was puzzled by the first report which came to him concerning "solium." The phenomenon described from Paris did not seem to him to be natural, and he was not one of those who spent much time searching for the new element in this country. Instead, he caused an investigation to be made, and he has just received word which confirms what he has believed all along to be the case, that there is no such element as "solium." "I have just received an answer to some questions sent by me to Paris," says Dr. Kunz, "and I am not surprised to learn that 'solium' is not an element, but a hoax. Research has been made by M. Guillaume, director of the International Bureau of Weights and Measures, and the admission has been made to him that the 'discoverer' of 'solium' merely took advantage of the wide interest in radio active substances to perpetrate a joke on the world at large."

MR. F. E. KINSMAN, in a letter to the *New York Times* on third rail dangers, says: "The cheapest and at the same time the most practical plan consists of returning the current by the furthest away traffic rail, reinforced by such return feeders as circumstances require. They need be no larger than the "third rail," nor any more heavily bonded than is now provided for the outgoing "third rail," thus eliminating the use of the traffic rail nearest the "third rail" as a return conductor. Insulating it sectionally increases the safety factor of this arrangement. It will be readily seen that the chances of a short circuit between the "third rail" and the return conductor are thus reduced by the square of the distance, which in the present practice would be between five and six feet. A person cannot step or reach across this space without unusual effort. The tools of the workmen should not be long enough to bridge this distance. The dropping of a piece of metal across the near-by rail would produce no dangerous effect, unless there was a car in the section while the accident occurred, which is unlikely, owing to the disposition to avoid the track near a moving train. The arrangement also admits of train signaling and control along the lines now being considered without use of alternating current."

Trade Notes.

PITTSBURGH TRANSFORMER COMPANY, of Pittsburgh, Pa., has issued a charming "Pretty Girl" calendar for January, the name of Mr. A. H. Mustard, New York agent, appearing on the copy that reaches us.

MR. RUSSELL HOWLAND, the advertising expert, etc., has moved from 150 Nassau Street, New York City, to 120 Liberty Street, in order to secure more room and be near many of his clients in the machinery district.

THE PHELPS COMPANY, Detroit, Mich., the maker of Hylo lamps, is putting out a colored glass sign which reads "Electrical Supplies," and is lit by one of its self-flashing sign lamps. A very attractive effect is thus produced.

G. M. GEST, the conduit contractor, etc., has issued a large and handsome calendar for 1904, the illustration on which is a double manhole built by him for the Louisville, Ky., Railway Company. The background card is a Pompeian red.

COMMERCIAL ELECTRIC COMPANY, Indianapolis, Ind., has just issued a very interesting little folder giving the exact figures of cost for properly installed isolated plants of 65,100 and 140 incandescent lights, so that a man can tell in advance what an equipment is likely to cost him.

LAMPS ON WILLIAMSBURG BRIDGE.—The incandescent lamps (20,000 in number) used to illuminate the new East River bridge at the opening last week were furnished by the Munder Electric Company through its sales agent, C. J. Purdy.

LOOMIS-PETTIBONE GAS MACHINERY COMPANY, of 52-54 William Street, New York City, has recently opened branch offices as follows: Boston, State Mutual Building; Pittsburgh, Farmers' Bank Building; Chicago, First National Bank Building.

MANHATTAN ELECTRICAL SUPPLY COMPANY, New York and Chicago, has issued special new price lists and trade literature, including clearance lists of the New York store, electrical portable lamps of handsome design, and other specialties.

THE MECHANICS SUPPLY COMPANY, 96 Peter Street, Quebec, Canada, is introducing at a trivial price two charming little novelties for the new year, one being a tiny wrench and the other a dainty hammer. Both of them "work" perfectly. They are well made and heavily nickeled.

AUTOMOBILE WORK.—The Edison Electric Illuminating Company, of Boston, has recently issued a most interesting bulletin giving an account of the recent round trip with an Edison battery automobile, between Boston and New York. Another bulletin gives a list of charging stations available all over New England.

AUTOMATIC TELEPHONY.—Contractors will be interested in the descriptive matter issued by the Electric Appliance Company, Chicago, telling of its latest things in telephones of all kinds. Circulars can be had for the asking, giving full details of the new Dinsmore automatic telephone for inter-communicating work.

STANLEY AND NORTHERN.—The Stanley Electric Manufacturing Company and the Northern Electrical Manufacturing Company announce that they have established branch offices on the Pacific coast with headquarters at 69-75 New Montgomery Street, San Francisco, Cal., and sub-offices at the Pioneer Bldg., Seattle Wash., and the Douglas Bldg., Los Angeles, Cal.

THE MONSON BURMAH SLATE COMPANY, of Portland, Me., has received the highest kind of endorsement for its slate, both as to durability and adaptability for all electrical appliances and for the beauty of its finish, it being of uniform color and unfading black. The slate which it furnishes has a very high insulation test and is wholly free from moisture, absorption and metallic substances.

PASS & SEYMOUR, INC., Solvay, N. Y., have in press an edition of 25,000 catalogues to be distributed on Jan. 1, 1904. Anyone interested in the P. & S. specialties should drop a postal card to the firm when a copy will be mailed promptly. This catalogue shows a number of valuable and useful additions to the P. & S. line, as they have brought out many new specialties during the past year.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., reports a very gratifying business for the outgoing year of 1903, and asserts its belief that 1904 will witness still further improvement and development of its already immense business. The company states that it will continue to push with vigor the same specialties with which its name is already so well identified: viz. "Okonite" and "I. X. L." wires, "D. & W." enclosed fuses and safety devices, "Pittsburgh" transformers, and "Columbia" lamps.

THE WEBSTER CHEMICAL COMPANY, St. Paul, Minn., is manufacturer of Crystal Chemical Coloring, a compound for artificially coloring incandescent lamps. The material has been on the market for a number of years and the maker claims that it has never known of a case where it has not given complete satisfaction. It is said to remain good for a long period of time. Very pretty colors are secured, in addition to which there are opal, white and ground glass effects. The use of this compound is a convenient method for securing an attractive illumination without the expense of natural colored bulbs.

THE ECONOMICAL ELECTRIC LAMP COMPANY has issued a circular to supply dealers throughout the country in which the good points of its turn down lamp are attractively set forth. It dwells on the simplicity of the "String Pull" lamp and its positive action, on the saving of current when the smaller filament is burning, and on the fact that the lamps are furnished in various bases for differing voltages. The catch phrase employed by the company "Don't burn your hands" is emphasized by an illustration showing its needlessness when "Economical lamps" are used.

THE SMITH & HEMENWAY COMPANY has contracted with the Page Storms Drop Forge Company to handle the entire marketing on its engineer's wrenches and hereafter the latter concern's New York office will be 296 Broadway, care of the Smith & Hemenway Company, which will look after this end of its business exclusively. In addition to manufacturing drop forged engineer's wrenches, it makes a specialty of making forgings from blue prints or samples, for anyone desiring this class of work. Parties interested or wishing to have forgings made will make their requests known direct to the factory at Brightwood, Mass.

LINK-BELT SPROCKET WHEELS.—The Link-Belt Engineering Company, Nicetown, Philadelphia, has just issued a circular devoted to link-belt case-hardened sprocket wheels. By the company's new process of case-hardening it is stated that the teeth and rims of the wheels are made so hard as to be practically indestructible, at the same time giving them a smooth, uniform and close-grained surface. These wheels are of advantage in all link-belt gearing, but are particularly recommended for use in cement mills, phosphate plants, stone crushing plants and for all work where grit is present. The circular has an illustration showing the depth of chill produced by the case hardening process.

NAVY VENTILATION.—In no branch of government service has the matter of ventilation been given such serious consideration as in the navy. The construction of the modern vessel renders it extremely difficult to secure proper ventilation in some portions below the water line. Noticeable for its novelty, among the various methods used to properly ventilate such places, is the portable ventilating set, consisting of a small exhauster of the "Monogram" type directly connected to an enclosed electric motor. It is very light, moves a large body of air, and is provided with handles for carrying from place to place, enabling the crew to work in any portion of the vessel with comfort, and is but one of the many types of blowers manufactured by the B. F. Sturtevant Company, of Boston, Mass.

INDUSTRIAL RAILWAYS.—In the modern industrial railway equipment where turn-tables are used for out-door work there is always a temptation to set the turn-tables upon too shallow a foundation, the result being that they are thrown out of line by the influence of the frost. In the new plant of the B. F. Sturtevant Company, at Hyde Park, Mass., where special turn-tables of its own manufacture have been very successfully introduced in connection with its industrial system, each turn-table rests at the top of a brick circular well with 8-inch walls extending to a depth of 4 ft. or below the frost line. These walls are set upon hard-pan and the center filled with loose stones providing perfect drainage. The first winter's experience has shown them to be absolutely uninjured by frost.

"IDEAL" ELECTRICAL MACHINERY.—The Ideal Electric & Mfg. Company, of Mansfield, Ohio, has recently placed on the market a complete line of "Ideal" electrical machinery embracing a line of elevator and hoist motors and controllers, a line of universal motors, and a complete line of belted and engine-type dynamos and generators in sizes up to 150 horse power. This company, while apparently new in the field, is backed by men of long years of experience in the design and manufacture of electrical machinery. In its shops at Mansfield it is using individual motor drive applied to the most modern machine tool equipment, and already the demand for its machines has forced the necessity for increased facilities, and a large new brick building with three floors is under way and will be ready for occupancy early in the spring. It is the intention of the company to work into larger units as soon as the proper facilities can be provided.

MILLING MACHINES.—The Hess Machine Company, 15th and Chestnut Streets, Philadelphia, Pa., has just brought an attractive pamphlet on the subject of milling machines and milling cutters for large output. The company guarantees feeds per minute of 10 inches or more in roughing off cast iron the full width of the machine, and on steel forgings and steel castings, four inches or more. The cutters are made on a new principle and do not "hog in" when changing from wide to narrow surfaces at full rates of speed. The machines are designed for direct electric driving by direct and alternating current motors. The pamphlet contains several excellent illustrations of milling machines of different sizes, each being accompanied by a table giving all the principal dimensions, speeds, etc. There is also a telegraph code, a chapter on the Hess Company's cutters for fast feeding closes the pamphlet. All machinists will be interested in this machine as it is evidently a great time and money saver.

ELECTRIC CONTROLLERS.—J. L. Schureman & Co., of Chicago, have issued two handsome pamphlets, Bulletins Nos. 19 and 20, describing respectively their line of electric elevator controllers and self starters and pressure regulators for direct current motors. These contain descriptions, dimension tables and price lists of the apparatus manufactured by the company, which makes a specialty of controllers of various kinds. It will be recalled that the business was formerly conducted under the name of Schureman & Hayen, the partnership having been dissolved July 1, 1903. Subsequently the company's business in electrical machinery was disposed of to the Gregory Electric Company, since which time Schureman & Company have been devoting themselves to the manufacture of controllers exclusively. Although these have been placed on the market for a number of years, no effort has been made in the past to push the line, but an aggressive policy is now being pursued.

FRINK LIGHTING.—In the perfecting of modern buildings, many problems have been solved by the Frink system of lighting, well known in lighting churches and public buildings. Some of the recent installations furnish further proof of its efficiency: Madison Ave. Baptist Church, Church of St. Edward the Martyr, Rutgers Presby. Church, Church of the Incarnation, Church of the Covenant, New York City. Immanuel Bapt. Church, Albany, N. Y. Westminster Presby. Church, Yonkers, N. Y. Church of St. Peter of Alcantara, Port Washington, L. I. First Presby. Church, Wheeling, W. Va., M. E. Church, Morristown, N. J. The New Amsterdam Theatre, probably the handsomest in New York, offers an excellent example of illumination by lights concealed in Frink cove reflectors. The effect is especially fine in the foyer, the fullest appreciation of the decoration of which is made possible only through the skillful handling of the lighting. Progressive merchants everywhere evidence their desire to share the benefits of Frink reflectors by equipping their windows with Frink special patent window reflector; show cases with reflectors especially designed for them and store interiors with special cluster reflectors which are economical and of highest efficiency. Full information concerning any of the above lines may be had by addressing the inventor, patentee and sole manufacturer, I. P. Frink, No. 551 Pearl St., New York City.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED DECEMBER 22, 1903.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

747,345. SIGNALING APPARATUS; James E. Allison, St. Louis, Mo. App. filed Aug. 30, 1902. Details of a system wherein trains can signal the station agent.

747,354. ELECTRIC WELDING MACHINE; George Baehr, McKeesport, Pa. App. filed Aug. 6, 1902. A machine for electrically welding tubes in continuous lengths.

747,367. FLEXIBLE METALLIC TUBING FOR ARMORING INSULATED ELECTRICAL CONDUCTORS; Wm. H. K. Bowley, London, Eng. App. filed Nov. 17, 1902. A corrugated strip of metal coiled so that each turn is partially overlapped by the next succeeding turn, a strip of metal being wound in the spaces between the corrugations.

747,371. TROLLEY WHEEL; Herbert W. Brockett, Hamden, Conn. App. filed June 23, 1903. Two disks flank the wheel and being of greater diameter than the latter, tend to retain the wheel on the wire.

747,394. TELEPHONE WALL SET; Ernest B. Fahnstock, New York, N. Y. App. filed April 13, 1903.

747,421. MULTIPLE SWITCHBOARD; Carl M. Hedman, Chicago, Ill. App. filed May 22, 1902.

747,446. ELECTRIC LIGHTING ATTACHMENT FOR GAS STOVES; Samuel Lewellen, Philadelphia, Pa. App. filed Dec. 9, 1902. Sparking electrodes are moved at the same time the valve is turned.

747,454. ELECTRIC CONDUCTOR; Victor Lowendahl, Stockholm, Sweden. App. filed Feb. 7, 1903. Masses of granular carbon covered with metal are compressed into blocks to form a carbon brush.

747,470. SUPPORT FOR ELECTRICAL CONDUCTORS; Robert Orr and John Morrison, New York, N. Y. App. filed Jan. 9, 1903. A trolley clip consisting of two connected members each being provided with a wedge-shaped groove, a wedge-shaped wire-gripping clip being secured in the groove.

747,477. RAIL INSULATOR; Leonard M. Randolph, Newark, N. J. App. filed May 4, 1903. A non-porous insulating covering for ground rails, consisting of varnish residue and an absorbent substance pressed into intimate contact with the rail.

747,491. TELEPHONY; Harry O. Rugh, Chicago, Ill. App. filed June 2, 1902.

747,508. REGULATING DEVICE FOR ELECTRIC ARC LAMPS; Aron N. Thorin, Stockholm, Sweden. App. filed Aug. 2, 1902. A roller in contact with the carbon has its axle resting freely against an inclined frame and a spring dog engages the roller in such a manner that it is permitted to move down the incline with the carbon rod at each feeding operation and to finally grip the rod.

747,515. TELEPHONE OR LIKE CABLE; Francis Tremain, Highgate, Eng. App. filed Nov. 1, 1901.

747,528. FUSE AND FUSE-MAGAZINE; William P. Woodruff, Buffalo, N. Y. App. filed June 12, 1903.

747,537. ELECTRICAL SWITCH; George J. Crossland, Mobile, Ala. App. filed July 12, 1902. Details of a circuit closer for operating an electro-magnetic railway switch.

747,553. CONNECTOR FOR ELECTRIC CIRCUITS; Wm. H. Kelsey, Cambridge, Mass. App. filed Sept. 24, 1902. A plug having two different styles of contact is arranged to be reversible upon a holder so that either set of contacts can be used.

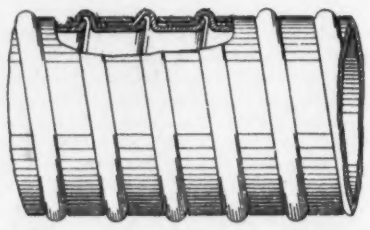
747,571. WINDING DEVICE FOR CABLES TO WHICH MOVABLE ELECTRIC APPARATUS IS ATTACHED; Gregor Ackermann, Biel, and Gustav Engisch, Madretsch, Switzerland. App. filed Nov. 5, 1902. Details of a spring drum arrangement for winding up a flexible cord.

747,595. COIL FOR ELECTRICAL MACHINES; Isaac De Kaiser, Pittsburg, Pa. App. filed May 1, 1903. The coil comprises an inner and an outer concentric portion, wound in opposite directions and having leads projecting from adjacent turns of the outer portion.

747,602. BATTERY TRANSMITTER; John S. Goldberg, Chicago, Ill. App. filed Nov. 17, 1902.

747,607. TROLLEY POLE; Jonah R. Hollis, Brockton, Mass. App. filed Nov. 7, 1902. The trolley harp is pivoted to permit the wheel to swing laterally.

747,609. ROSETTE; Edward J. Hunt, Toledo, Ohio. App. filed June 3, 1903. Details.



747,367.—Flexible Metallic Tubing for Armoring Insulated Electrical Conductors.

747,631. FIELD MAGNET COIL FOR ELECTRICAL MACHINES; Loyall A. Osborne, Pittsburg, Pa. App. filed June 24, 1903. The coil is formed of scrap copper and sheets of heat-resisting insulation between adjacent turns, the structure being inclosed in a hermetically shell.

747,673. ELECTRIC SWITCH; Charles C. Badeau, Swissvale, Pa. App. filed Aug. 12, 1903. Details of an overload switch.

747,686. SYSTEM OF ELECTRICAL REGULATION; John L. Creveling, New York, N. Y. App. filed Feb. 12, 1902. In a train lighting system where the generator is driven from the axle and supplies an accumulator, the generator is controlled automatically by the voltage of the accumulator.

747,696. BRUSH HOLDER; Henry Geisenhoner, Schenectady, N. Y. App. filed Dec. 17, 1900. The springs are mounted in hinged frames so that they can be tilted to one side when the brushes are to be removed.

747,697. ELECTRIC FUSE; Hanry Geisenhoner, Schenectady, N. Y. App. filed May 31, 1901. The fusible strip is threaded back and forth through transverse openings in the cartridge, to prevent the formation of an arc.

747,698. DYNAMO ELECTRIC MACHINE; Henry Geisenhoner, Schenectady, N. Y. App. filed Aug. 28, 1901. The space between the teeth of the core is closed by a wooden wedge faced off with cement.

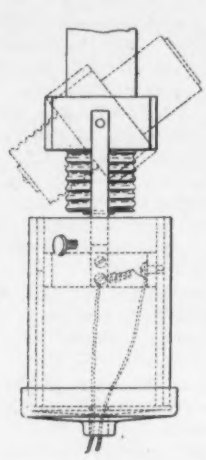
747,706. MAGNETIC CLUTCH; Edward M. Hewlett, Schenectady, N. Y. App. filed June 18, 1902. A stationary member contains the coil and attracts towards its opposite sides two rotary members.

747,707. ELEVATOR; Nelson Hiss, New York, and Harold S. Macaye, Yonkers, N. Y. App. filed May 31, 1902. Means whereby the car may be brought gradually and easily to rest at either end of its normal travel independently of the use of the ordinary controlling handle.

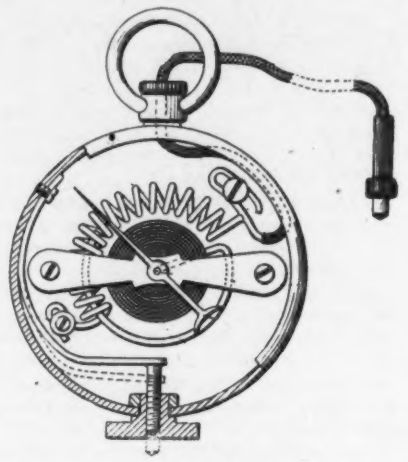
747,755. SPARK OIL; Charles P. L. Noxon, Syracuse, N. Y. App. filed Aug. 20, 1902. The face of the armature of the vibrator is grooved for the purpose of emphasizing the attractive force of the core.

747,763. REGISTERING MECHANISM; William H. Pratt, Lynn, Mass. App. filed Sept. 24, 1901. The combination with an integrating meter of means for registering thereby any excess of the quantity measured over a certain predetermined amount.

747,765. RAILWAY MOTOR; Edward D. Priest, Schenectady, N. Y. App. filed Sept. 16, 1902. Structural details relating to the split motor frame whereby the advantages of a box frame are also obtained.



747,553.—Connector for Electric Circuits.



747,871.—Measuring Instrument.

747,778. EXPRESS OR OTHER ANNUNCIATOR; Joseph H. Rusby, Nutley, N. J. App. filed Nov. 15, 1902. An electric sign containing the names of express companies with suitable switching apparatus for displaying any of them.

747,795. AUTOMATIC APPARATUS FOR CONTROLLING AND OPERATING THE POINTS OF ELECTRIC RAILWAYS OR TRAMWAYS; Thomas B. Stewart, Wm. H. Turner and Rowland E. Dixon, Leeds, Eng. App. filed April 1, 1902. Details.

747,796. APPARATUS FOR CONTROLLING AND OPERATING THE POINTS OF ELECTRIC RAILWAYS OR TRAMWAYS; Thomas B. Stewart, Wm. H. Turner and Rowland E. Dixon, Leeds, Eng. App. filed March 6, 1903. Details.

747,821. STARTING RHEOSTAT; Howard B. Wilson, Schenectady, N. Y. App. filed Aug. 21, 1902. The contact carried by the arm or a rheostat is in two parts, one being of higher resistance than the other, thus dividing the total current into two parts with a resulting diminution of sparking.

747,841. ELECTRIC APPARATUS FOR WELDING TUBES; George Baehr, McKeesport, Pa. App. filed Jan. 31, 1902. A machine in which flat plates are progressively bent into tubular form and the joint electrically welded, with adjustments for different sizes of tube.

747,842. ELECTRIC APPARATUS FOR WELDING TUBES; George Baehr, McKeesport, Pa. App. filed Jan. 31, 1902. The electric heating and welding apparatus is self-propelling along the tube blank to progressively heat and weld together the abutting edges of the blank.

747,847. STREET RAILWAY SWITCHING MECHANISM; Walter J. Bell, Los Angeles, Cal. App. filed May 7, 1903. Hydraulic pistons for moving the switch are locked and released by an electro-magnetic latch.

747,853. RETARDING DEVICE FOR ELECTRIC CIRCUIT BREAKERS; Algernon R. Cheyney, Philadelphia, Pa. App. filed April 16, 1903. A circulatory system for liquid is combined with a solenoid to get proper retardation of the core.

747,871. ELECTRICAL MEASURING INSTRUMENT; Earl C. Eldredge, Springfield, Mass. App. filed Oct. 3, 1903. A pocket volt-meter in which one of the contacts is at the end of a flexible cord, while the other is housed within the case, but can be readily extended when needed.

747,873. COMMUTATOR; Hermann F. T. Erben, Schenectady, N. Y. App. filed Aug. 10, 1901. Structural details.

747,876. INSULATING WIRE; Henry W. Fisher, Pittsburg, Pa. App. filed Nov. 1, 1902.

747,889. ELECTRIC LIGHTING SYSTEM; James F. McElroy, Albany, N. Y. App. filed Oct. 21, 1902. The regulator is controlled by a series of adjusting magnets included in separate lamp circuits, a storage battery being in multiple with the lamps and the dynamo being driven from a car axle.

747,890. BRUSH HOLDER FOR ELECTRICAL MACHINES; James E. McElroy, Albany, N. Y. App. filed March 5, 1903. A construction permitting the spring pressure to be relieved before reversing the holder or follower from its working position.

747,891. IMPLEMENT FOR FILLING WOOD SURFACES; Lewis W. Nelson, Grand Rapids, Mich. App. filed April 9, 1903. An electric heater applied to a heating iron.

747,911. CONNECTION TERMINAL AND PLUG; William W. Dean, Chicago, Ill. App. filed Dec. 26, 1900.

12,185. CONNECTION COUNTER FOR TELEPHONE LINES; Frank R. McBerty, Evanston, Ill. App. filed Jan. 16, 1900.